CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

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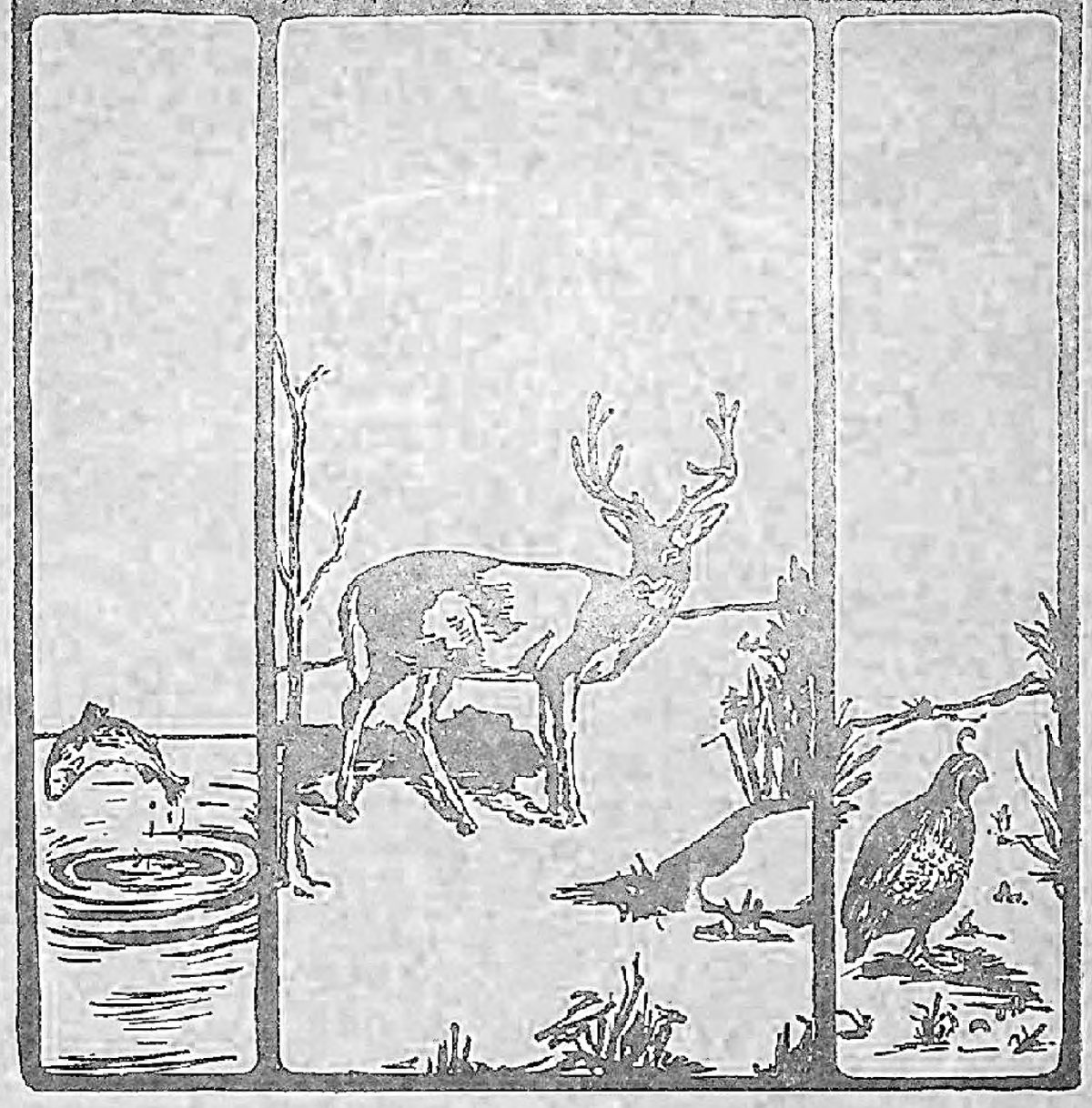

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GENERAL REPORT OF INVESTIGATIONS ON THE McCLOUD RIVER DRAINAGE IN 1938[1]

By J. H. WALES
Bureau of Fish Conservation
California Division of Fish and Game

Introduction

This paper reports the general features of the McCloud River drainage in northern California, presenting a picture of the whole McCloud drainage, its history and its future as regards the trout. The survey work was done during the summer and fall of 1938 and the winter of 1938-39. The more detailed points of the survey are recorded on the regulation stream survey forms, filed with the California Division of Fish and Game.

Although the survey work was done by the writer alone, he is indebted to several persons for information and material help. Some of these are: Mr. Cooper Smith and Mr. Earl F. Sullaway of the United States Forest Service, and other members of this organization; the members of the McCloud River Club, the manager of the club, Mr. Donald Wills, and the club's guide, Mr. Joseph Campbell, son of Mr. J. B. Campbell, mentioned later in this paper; Mr. William Reed, caretaker of the Bollibokka Club; Mr. A. F. Dobrowsky of Redding; the late Mr. E. V. Cassell, superintendent of the Mt. Shasta Hatchery; Mr. E. N. Kower, superintendent of W. R. Hearst's estate on the McCloud River; and Mr. H. C. Braden, assistant general manager of the McCloud River Lumber Company.

To those who are not familiar with the McCloud, a few words of introduction are in order. This river is one of the largest streams of the upper Sacramento River system. It heads to the southeast of Mount Shasta and flows into the Pit River just above the confluence of that river with the Sacramento. The waters of the Shasta Reservoir will cover the present mouth of the McCloud. It was the McCloud River which furnished the eggs for the transplanting of rainbow trout to eastern states and many foreign countries during the 1880's, so that the McCloud rainbow is still known as "the rainbow of the fish culturist." The McCloud is still a fine rainbow stream, although a flow of mud from the slopes of Mount Shasta has adversely affected it for the past fifteen years.

History of the McCloud River and Early Rainbow Trout Propagation

While trapping beaver on the McCloud River in northern California in 1828, Alexander Roderick McLeod and his party were caught in an early snowstorm and before spring released them, they had lost all their horses and were almost dead from starvation. One account

[1] Submitted for publication, September, 1939. Photographs by the author.

has it that all died but McLeod, who made his way back to the Hudson Bay Station at Vancouver. Apparently the name of the river was not definitely established, because in 1850 Ross McCloud, grandfather of Ross and George McCloud, who are now in the employ of the California Division of Fish and Game, settled on the river and the spelling of the river's name seems to have been changed from McLeod to McCloud.

The McCloud River was the principal area populated by the Wyntoon tribe of Indians but very few white men settled on it before 1872. In this year, Spencer F. Baird, U. S. Commissioner of Fish and Fisheries, sent Livingston Stone, one of the foremost trout breeders in this country, to California. Stone was instructed to find where the Pacific salmon bred and if possible, establish a station there from which eggs could be shipped to various parts of the Union and to foreign countries. Stone contacted the California Commissioners of Fish and Game but they did not know on what part of the Sacramento River the spawning fish could be found. He was informed by an official of the Central Pacific Railroad that Indians had been seen catching ripe fish in the McCloud River just above its junction with the Pit River. So Stone, following the California-Oregon stage route which ran from Redding to Yreka and north, reached the McCloud River toward the end of the spawning season of 1872. He succeeded in shipping out 30,000 eggs that year and established a station which operated almost continually for 65 years.

This station at Baird was devoted exclusively to the propagation and distribution of the king salmon (*Oncorhynchus tschawytscha*), and as we are not at the moment interested in this fish we need not consider its operations for the first seven years. In July, 1879, Stone received instructions from Commissioner Baird to establish a station, if possible, where the eggs of the rainbow trout could be collected for distribution. This fish was known commonly as the mountain or red-banded trout and its scientific names have been several. It was thought at first to be *Salvelinus iridea*; the generic name was later changed to the proper *Salmo*, and in 1894 Jordan named the species *Salmo shasta*. At present the fish is not considered a species distinct from *Salmo irideus* and as *irideus* is preceded in taxonomic literature by *Salmo gairdnerii* the McCloud rainbow had best be given the latter name, at least for the present.

Concerning the river itself Stone said in his report on the Sacramento salmon (1874):

> It is another peculiarity of the river (and it can hardly be said of any other river in California), that it has been abandoned to the Indians. The miner's pick and shovel have upturned the banks of other rivers, or the farms of white men have stretched along their waters, but, for some reason or other, the civilized races have very singularly left the McCloud River to its aboriginal inhabitants. The consequence is, that the McCloud River presents an instance of what is becoming extremely rare, at least in the more accessible portions of the country, namely, a region which is just as it was before the white man found it, and a race of aborigines, whose simple habits have not been corrupted by the aggressive influence of communication with the whites.

In July, 1879, Stone, accompanied by Greene and Redcliff, went by horse up the Indian trail along the river to Nosoni Creek about ten miles above the salmon hatchery at Baird. Nosoni is a beautiful trout stream but there are no convenient flat areas nearby on which buildings

and ponds could be built. The McCloud River canyon has relatively few level areas—the small ones which do exist were called rancheries by the Wyntoons. It is evident that this name is derived from the Spanish as were several other Indian words. Most of the rancheries are at present pock-marked with shallow, round depressions over which the tepees or lodges were set.

FIG. 96. A quiet stretch on the McCloud River. The majority of the rainbow trout for the Greens Creek ponds were caught here. Mt. Persiphon in the background. Summer, 1938.

Stone retraced his steps down the McCloud, across Dekkas, Campbell and other smaller creeks until he came to one which met his requirements. It was only four miles above the Baird Hatchery and had a small ranchery near its mouth. Stone (1882) says:

We crossed several streams on our way down, but found none that were suitable till we reached the George Crook's Creek, four miles from home. Here, to our great delight, we found almost everything favorable. The stream ran clear and cold, and though not so large as Nosonnie Creek (now Nosoni), it was large enough. There was a long reach of comparatively still water in the McCloud at this point, where set-lines for catching parent trout could be advantageously set. There were sugar pines near for cutting out shakes and lumber, and oaks for fire-wood. There was a flat piece of ground just where we wanted it for the buildings and ponds, and although it was evidently going to be no small undertaking to get the water from the brook to the station, it was nothing compared with the immense labor it would have taken at Nosonnie. I was not long deciding to locate here, and on the next Monday morning at sunrise had taken possession of the land and had posted a notice on one of the trees that I had taken up the claim.

George Crooks, for whom the creek was named, had had a small ranch a short distance below the creek, but he was murdered by Indians in 1872. The Wyntoons, however, unless greatly provoked, were helpful and friendly. In fact, Stone said that if it had not been for the Indians helping them at the salmon hatchery he doubted if they could have continued. Despite their friendliness with Stone and his party, the tribe had occasional wars with the more fierce Modocs, and overlooking Nosoni Creek is a deep cave in which the braves hid their wives and children during times of trouble.

After deciding upon the pond site at Crooks Creek they built a rough camp, then later that summer built a cabin, a hatchery house sufficient for six million eggs and two ponds. Later another pond was added. These ponds were arranged as shown in figure 97. In October, 1938, I measured them roughly as follows: No. 1 was 24 by 14 feet, Nos. 2 and 3 were 10 by 14 feet. Their depth was between four and five feet. At present their walls, built of loose lava rocks, are still standing although considerable vegetation has overgrown them. The water supply ditch is about one hundred yards long and is still nearly usable.

In brief, the plan of operation of this station was to catch as many adult rainbow trout from the river on set lines as was possible and

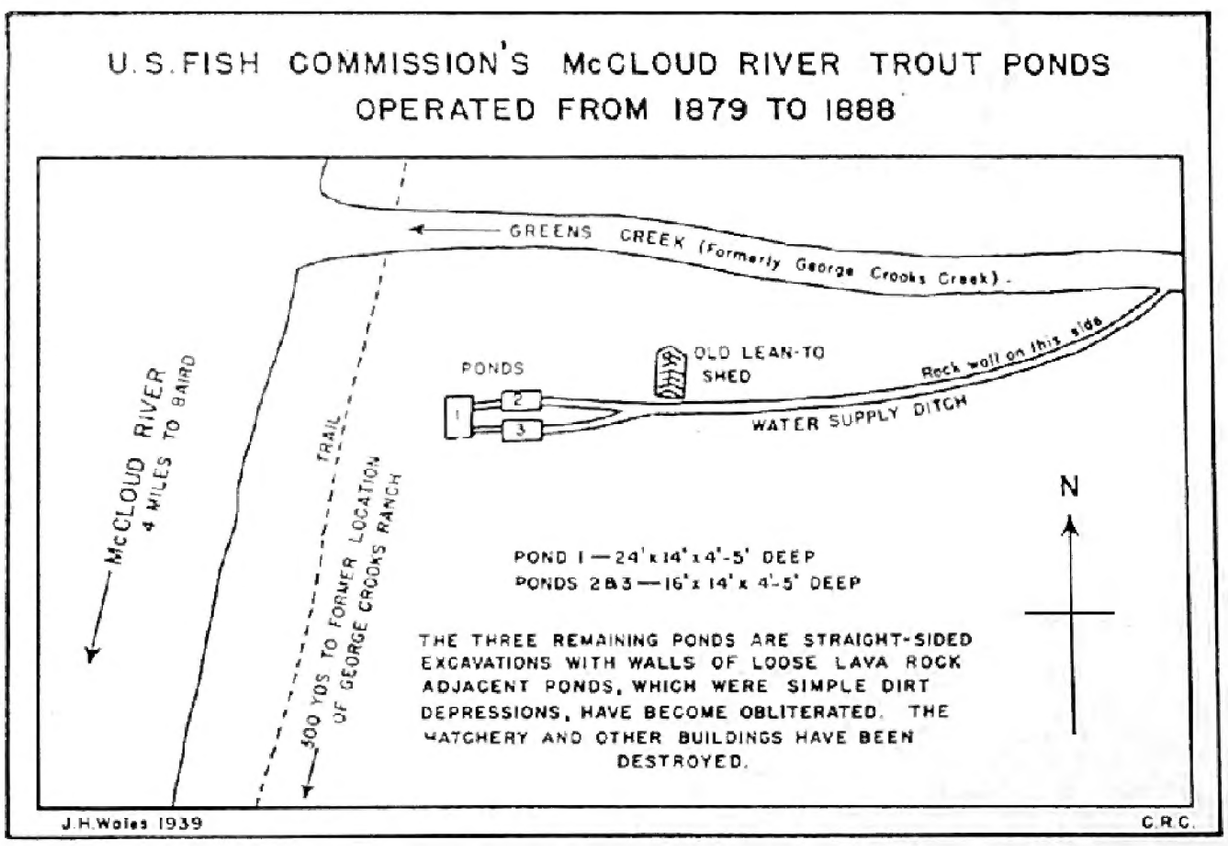

FIG. 97.

place them in the ponds. In the winter and early spring, trout ascended the creeks in large numbers, according to Stone, and these were trapped for the ponds. By Christmas of 1880 they had about 1500 rainbow, ranging in size from one and one-half to ten pounds, with an average of two pounds for the females and three pounds for the males.

These fish were held in the ponds and fed largely on boiled salmon, although during the winters it was necessary to supplement this food with venison and beef. When the fish started to ripen about the first of January they were spawned and the eggs held in the hatchery until eyed. Spawning continued from about January 1 to some time in May each year. After the eggs were eyed they were packed and taken on

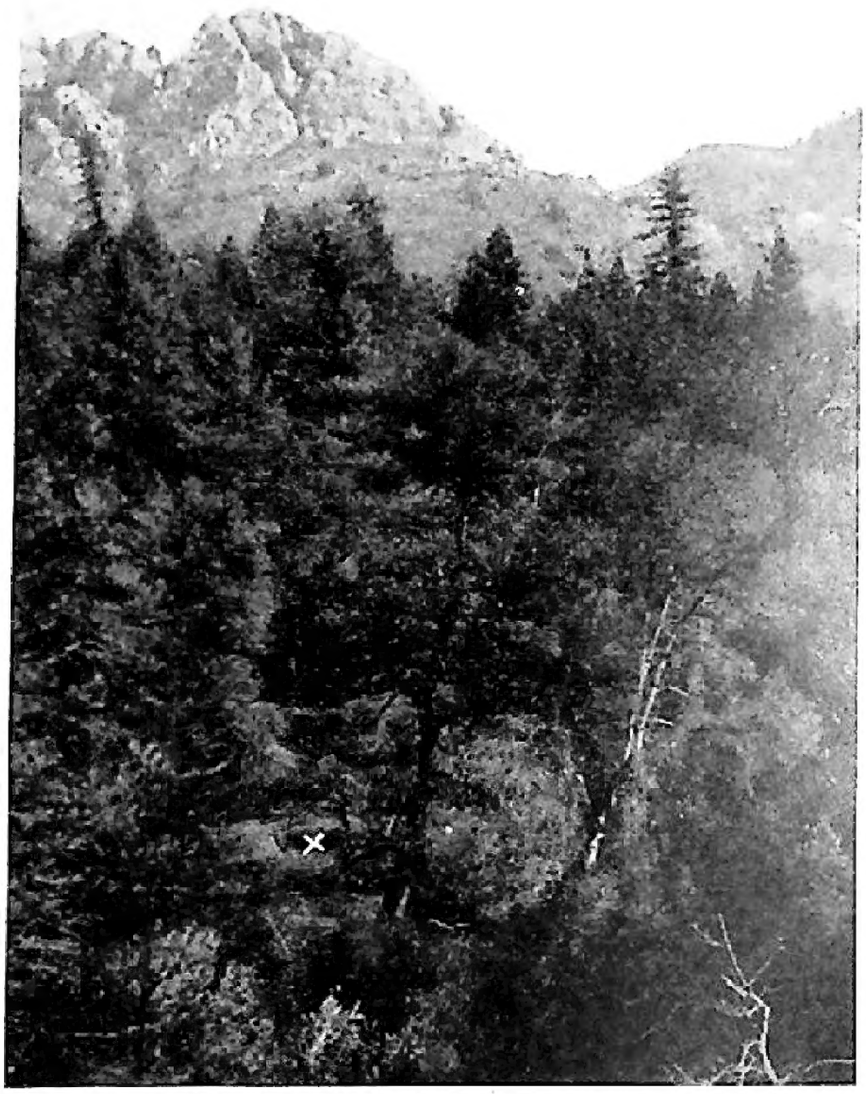

FIG. 98. Greens Creek. U. S. Bureau of Fisheries trout pond marked by cross. View from west side of river. Fall, 1938.

horseback over the Indian trail to the stage road at Baird. Here they were put on the stage coach or on a buckboard wagon and taken twenty miles south to the terminus of the Central Pacific Railroad (now the Southern Pacific) and shipped to the various states.

Naturally the egg collecting at Crooks Creek, or Greens Creek, as it was later called, had its ups and downs as do those activities at most stations in California. Several times during the operation of the ponds, heavy rainfall caused a rise in Greens Creek and so much sediment was brought in that many fish were killed. In 1881 a very bad storm destroyed the salmon hatchery four miles below at Baird and many of the brood fish at the Greens Creek ponds were killed at that time. In September, 1885, a serious disease broke out, both in the river and in

the ponds, and killed many fish. It is not strange, therefore, that it was necessary for Loren Green, who cared for the ponds in Stone's absence, to spend as much time as possible catching fish to replenish his ponds. More than once during the eight years of operation Stone reported that they had about 2000 fish in their ponds. In view of the heavy losses, I estimate that about 5000 adult rainbow were caught on set lines and taken in traps during these years. This work was carried on mainly within a ten-mile stretch of river. It is hardly necessary to point out that this is a large number of adult fish to be caught from such an area of water.

The hatchery building at Greens Creek was built to accomodate 6,000,000 eggs, but as a matter of fact only 2,676,725 eggs were taken in all the nine years of operation. This is an average yearly take of 297,414 eggs. If a thousand females were spawned each year this would represent only 297 eggs per fish. If only 500 females were spawned each year the average would be only 594 eggs apiece. We know from subsequent experience that rainbow trout weighing two pounds should average between one and two thousand eggs. It is also interesting to note that S. Akekio of Tokyo, Japan, reported that in 1880, three years after his eggs from the McCloud River hatched, the fish weighed five pounds and yielded 4000 eggs apiece. Someone is evidently mistaken.

The eggs taken on the McCloud were said to be of a size so that 25 would cover a square inch. This would make them approximately 285 per ounce.

Although the federal government probably sent out the larger number of McCloud eggs and their shipments were the more widely known, J. B. Campbell, who settled on the river in 1855, was actually the first to collect rainbow eggs and ship them from the McCloud. In fact, Campbell may very well have been the first person to collect and ship any rainbow eggs, not only from the McCloud River but from any water in the original Pacific Coast range of the rainbow trout.

FIG. 99. Lean-to shack beside the ponds at Greens Creek. Summer, 1938.

Campbell's ranch was located on the creek which bears his name, two and a half miles above Greens Creek. He apparently shipped the first eggs out in 1874, two years after the salmon station was begun at Baird and six years before Livingston Stone sent trout eggs from the ponds at Greens (or Crooks) Creek. Just where Campbell sent his eggs we do not know except that Seth Green (1882), living in New York State, said in 1881 that seven years before he had received 300 rainbow eggs from the McCloud River. In the same report, mention is made that Campbell had supplied Green with most of the rainbow eggs that the latter had obtained.

TABLE I

Distribution of McCloud Rainbow Eggs, 1874-1887

Date	Number of eggs shipped	Shipper	Recipient	Address
1874	300	J. B. Campbell	Seth Green	Mumford, New York
1877	10,000	J. B. Campbell	S. Akekio	Tokyo, Japan
1880	175,000	U.S. Fish Commission	T. B. Ferguson	Baltimore, Maryland
1880	1,500	U.S. Fish Commission	M. Metcalf	Battle Creek, Michigan
1880	2,500	U.S. Fish Commission	R. O. Sweeney	St. Paul, Minnesota Fish Commission
1880	3,500	U.S. Fish Commission	B. F. Shaw	Anamosa, Iowa Fish Commission
1880	2,500	U.S. Fish Commission	W. Welsher	Wisconsin
1880	2,500	U.S. Fish Commission	S. Webber	New Hampshire
1880	2,500	U.S. Fish Commission	F. N. Clark	Northville, Michigan, U.S.Fish Commission
1880	2,500	U.S. Fish Commission	J. G. Portman	Pokagon, Michigan
1880	2,500	U.S. Fish Commission	N. K. Fairbanks	Chicago, Illinois
1880	10,000	U.S. Fish Commission	C. S. White	Green Spring River
1880	4,000	U.S. Fish Commission	Seth Weeks	Corry, Pennsylvania
1880	4,000	U.S. Fish Commission	Potter	
1880	30,000	U.S. Fish Commission	J. G. M. Steedman	St. Louis, Missouri
1880	10,000	U.S. Fish Commission	R. Koltz	Shasta County, California
1880	68,000	U.S. Fish Commission	Hatched and planted in McCloud River	
1881	40,000	U.S. Fish Commission	T. B. Ferguson	Baltimore, Maryland
1881	35,000	U.S. Fish Commission	B. F. Shaw	Anamosa, Iowa Fish Commission
1881	35,000	U.S. Fish Commission	N. K. Fairbanks	Chicago, Illinois
1881	40,000	U.S. Fish Commission	B. B. Redding	California Fish Commission
1881	4,000	U.S. Fish Commission	S. Webber	New Hampshire
1881	6,000	U.S. Fish Commission	J. G. Portman	Pokagon, Michigan
1881	8,000	U.S. Fish Commission	R. O. Sweeney	St. Paul, Minnesota Fish Commission
1881	5,000	U.S. Fish Commission	Philo Dunning	Wisconsin
1881	5,000	U.S. Fish Commission	W. Griffith	Kentucky
1881	5,000	U.S. Fish Commission	J. P. Creveling	Pennsylvania
1881	500	U.S. Fish Commission	E. G. Blackford	New York Fish Commission
1882	95,000	U.S. Fish Commission	F. N. Clark	Northville, Michigan, U.S. Fish Commission
1882	33,000	U.S. Fish Commission	Central Hatchery Station	Washington, D.C.
1882	30,000	U.S. Fish Commission	E. G. Blackford	New York Fish Commission
1882	5,000	U.S. Fish Commission	R. O. Sweeney	St. Paul, Minnesota Fish Commission
1882	10,000	U.S. Fish Commission	M. F. Bailey	Wisconsin
1882	10,000	U.S. Fish Commission	Seth Weeks	Corry, Pennsylvania
1882	10,000	U.S. Fish Commission	Calvin Fletcher	Indiana
1882	10,000	U.S. Fish Commission	C. H. Brownell	Mississippi
1882	10,000	U.S. Fish Commission	J. G. Portman	Michigan
1882	5,000	U.S. Fish Commission	Peter Walsh	Colorado
1882	5,000	U.S. Fish Commission	E. M. Stillwell	Maine
1882	5,000	U.S. Fish Commission	Wm. Griffith	Kentucky
1882	10,000	U.S. Fish Commission	W. E. Sisty	Colorado
1882	10,000	U.S. Fish Commission	B. F. Shaw	Anamosa, Iowa Fish Commission
1882	5,000	U.S. Fish Commission	E. A. Brackett	Massachusetts
1882	1,000	U.S. Fish Commission	D. B. Long	Kansas
1882	10,000	U.S. Fish Commission	H. J. Fenton	Connecticut
1882	5,000	U.S. Fish Commission	C. H. Barber	Vermont
1882	30,000	U.S. Fish Commission	B. B. Redding	California Fish Commission
1882	10,000	U.S. Fish Commission	N. K. Fairbanks	Chicago, Illinois
1882	10,000	U.S. Fish Commission	Mrs. Slack	Illinois
1882	4,000	U.S. Fish Commission	C. S. White	Illinois
1882	4,000	U.S. Fish Commission	A. Powers	Illinois
1882	10,000	U.S. Fish Commission	Planted in McCloud River as fry	
1883	227,000	U.S. Fish Commission	S. F. Baird	U.S. Fish Commission, Washington, D.C.
1883	5,000	U.S. Fish Commission	B. F. Shaw	Anamosa, Iowa Fish Commission
1883	5,000	U.S. Fish Commission	Wm. Griffith	Louisville, Kentucky
1883	5,000	U.S. Fish Commission	G. W. Delawder	Baltimore, Maryland
1883	5,000	U.S. Fish Commission	E. A. Brackett	Winchester, Massachusetts
1883	5,000	U.S. Fish Commission	C. J. Huske	Columbia, South Carolina
1883	5,000	U.S. Fish Commission	J. S. Logan	St. Joseph, Missouri
1883	5,000	U.S. Fish Commission	Geo. Jeliffe	Westport, Connecticut
1883	5,000	U.S. Fish Commission	C. S. White	Romney, West Virginia
1883	5,000	U.S. Fish Commission	E. B. Kennedy	Omaha, Nebraska
1883	5,000	U.S. Fish Commission	D. Y. Howell	Toledo, Ohio
1883	5,000	U.S. Fish Commission	Col. M. McDonald	Wytheville, Virginia, U.S. Fish Commission
1883	5,000	U.S. Fish Commission	G. W. Riddle	Plymouth, New Hampshire
1883	45,000	U.S. Fish Commission	E. G. Blackford	Fulton Market, New York Fish Commission
1883	20,000	U.S. Fish Commission	Planted as fry in McCloud River	
1883	12,000	U.S. Fish Commission	Put in ponds on McCloud River	
1883	24,000	U.S. Fish Commission	Lost	

TABLE I—Continued

Distribution of McCloud Rainbow Eggs, 1874-1887

Date	Number of eggs shipped	Shipper	Recipient	Address
1884	12,000	U.S. Fish Commission	R. O. Sweeney	St. Paul, Minnesota Fish Commission
1884	12,000	U.S. Fish Commission	B. F. Shaw	Anamosa, Iowa Fish Commission
1884	11,000	U.S. Fish Commission	B. E. B. Kennedy	Omaha, Nebraska
1884	125,000	U.S. Fish Commission	Col. M. McDonald	Wytheville, Virginia, U.S. Fish Commission
1884	45,000	U.S. Fish Commission	Shebley Hatchery	On railroad between Grass Valley and Colfax, California
1884	21,200	U.S. Fish Commission	Kept in ponds, McCloud River	
1884	51,500	U.S. Fish Commission	Returned as fry to McCloud River	
1884	58,325	U.S. Fish Commission	Destroyed by storms, etc.	
1885	171,000	U.S. Fish Commission	S. F. Baird	U. S. Fish Commission, Washington, D.C.
1885	10,000	U.S. Fish Commission	Gordon Land	Denver, Colorado
1885	10,000	U.S. Fish Commission	A. M. Spangler	Philadelphia, Pennsylvania
1885	10,000	U.S. Fish Commission	Otto Gramm	Laramie City, Wyoming Fish Commission
1885	15,000	U.S. Fish Commission	B. E. B. Kennedy	Omaha, Nebraska
1886	24,000	U.S. Fish Commission	Central Station	Washington, D.C.
1886	12,000	U.S. Fish Commission	E. B. Hodge	Plymouth, New Hampshire
1886	45,000	U.S. Fish Commission	H. M. Garlichs	St. Joseph, Missouri
1886	10,000	U.S. Fish Commission	H. A. Cutling	Plymouth, New Hampshire
1886	10,000	U.S. Fish Commission	B. E. B. Kennedy	Omaha, Nebraska
1886	20,000	U.S. Fish Commission	Otto Gramm	Laramie, Wyoming Fish Commission
1886	10,000	U.S. Fish Commission	A. W. Aldrich	Anamosa, Iowa
1886	5,000	U.S. Fish Commission	Hatched for the McCloud River	
1886	30,000	U.S. Fish Commission	Lost by high water and mud	
1887	45,000	U.S. Fish Commission	Central Station	Washington, D.C.
1887	20,000	U.S. Fish Commission	E. D. Carlton	Spirit Lake, Iowa
1887	10,000	U.S. Fish Commission	B. E. B. Kennedy	Omaha, Nebraska
1887	25,000	U.S. Fish Commission	R. O. Sweeney	St. Paul, Minnesota Fish Commission
1887	20,000	U.S. Fish Commission	H. M. Garlicks	St. Joseph, Missouri
1887	20,000	U.S. Fish Commission	F. N. Clark	Northville, Michigan, U.S. Fish Commission
1887	5,000	U.S. Fish Commission	R. Kroeck	Denver, Colorado
1887	5,000	U.S. Fish Commission	Hatched for the McCloud River	
1887	84,000	U.S. Fish Commission	Lost from various causes	
1888	38,000	U.S. Fish Commission	R. O. Sweeney	St. Paul, Minnesota Fish Commission
1888	25,000	U.S. Fish Commission	Otto Gramm	Laramie, Wyoming Fish Commission
1888	33,000	U.S. Fish Commission	E. Chazari	Mexico Fish Commission
1888	347,000	U.S. Fish Commission	To be hatched and planted in McCloud River	

Total shipped —2,676,725 for the nine years of operation of the U.S. Fish Commission ponds.

In 1877, S. Akekio of Tokyo, received 10,000 McCloud rainbow eggs from B. B. Redding, Fish Commissioner of California. At that time Redding could not have obtained eggs from the federal station and very probably secured them from Campbell.

It would be interesting to know more definitely the names of the streams into which McCloud rainbow trout offspring were planted, but planting records were not kept as accurately in those early days as they are at present. The various states that received shipments of eggs may have kept records of the localities where fry were planted, but generally speaking the information is probably no more complete than it is for California streams. The first few biennial reports of the California Fish Commission yield a few interesting notes on the McCloud River and its trout, but the following record appearing in 1878 and 1879 is the only record of planting occurring in these early reports.

March 30, 1878	Russian River and tributaries	6,000
March 30, 1878	Santa Rosa and Mark West creeks	3,000
April 5, 1878	Santa Cruz, Aptos creeks, etc.	4,000

April	8, 1878	Alameda Creek and tributaries	2,500
April	7, 1878	Streams in Santa Clara County	2,000
April	18, 1878	Streams in Santa Cruz County	10,000
May	9, 1878	San Lorenzo Creek, Alameda County	1,000
May	9, 1878	Streams in Alameda County	5,000
March	21, 1879	Streams in Santa Cruz and San Mateo counties	7,000
March	27, 1879	Streams in Santa Clara and Monterey counties	9,000
March	29, 1879	Yosemite Valley	20,000
April	1, 1879	San Gregorio Creek and Pescadero Creek	8,000
April	1, 1879	Streams in Alameda County	1,000
April	3, 1879	Tuolumne River	2,000
April	7, 1879	Streams in San Mateo County	7,000
April	15, 1879	Streams in Alameda County	6,700

It seems logical to presume that the distribution of McCloud rainbow in California and elsewhere was followed in later years by rainbow from other sections of the State and by steelhead fingerlings. This indiscriminate distribution was typical of the early period of American fish culture and has resulted in such a mixture of strains that it is usually a hopeless task to determine the origin of any one population.

Although rainbow eggs were sent to several foreign countries during the time the McCloud River Station was operating, it appears that these were not sent directly from California but were eggs from fish at the Wytheville, Virginia, and Northville, Michigan, stations. These fish were, of course, from eggs which had been sent from the McCloud River. Germany, England and France were at least some of the countries to which eggs from the McCloud rainbow strain were sent. Since that time most of the countries in temperate and boreal latitudes have experimented with rainbow. In New Zealand, at least, the rainbow trout have succeeded better than in North America.

Several of the earliest shipments of rainbow trout eggs from the McCloud River to other states appeared to have been very successful. Whether we should accept all the favorable comments without reservation I should hesitate to say.

Metcalf (1883) said that in March, 1883, they took eggs from three-year-old McCloud rainbow which weighed nearly 3½ pounds. He added that the rainbow are much more vigorous and desirable in every way to brook trout for Michigan streams; that during spawning they are free from disease and grow four times as fast as the brook trout under like conditions, and that they can be kept in water much warmer than any other salmonoid.

Clarke (1885) of the South Side Sportsmen's Club of Oakdale, Long Island, wrote Baird that four-year-old rainbow from the McCloud weighed 3¾ pounds. One specimen measured 23¾ inches.

A correspondent in Waterville, New York, wrote (Smiley, 1884) that the McCloud rainbow as fish a little over a year old weighed three-quarters of a pound.

Green (1882) said that in 1874 he received 300 McCloud rainbow eggs. He hatched 275 and by 1882 expected to have 30,000 three-year-olds yielding several million eggs. He said the rainbow will hatch a much larger proportion of eggs than the brook and that they will live in any stream the brook will live in and also in many warmer streams. Some of his six-year-old fish weighed three pounds.

Maynard (1889) said he found five-year-old rainbow in Spring River, Missouri, which weighed 4½ pounds dressed.

Max von dem Borne of Germany (1885) records 21-months-old rainbow weighing one-half to three-quarters of a pound, and 2½-year-old fish weighing three-quarters to one pound.

As an appropriate conclusion to this chapter on the early history of the McCloud and its rainbow, the following quotation is presented (McDonald, 1891):

This station (Baird Station) was established in 1879 for the propagation of the rainbow trout *(Salmo irideus)* and from it has been drawn the eggs to furnish a stock of breeders for the Eastern stations. The species is now well established at Northville, Michigan, and Wytheville, Virginia, and in the breeding ponds of various State Commissions. We will be able in future to meet all requests for eggs with the product of Eastern stations.

In view of this fact it has not been deemed advisable to continue the Baird Station in active operation. Accordingly, at the end of the season in June (1888), the station was closed, and the serviceable property removed to the salmon station on the McCloud River about four miles below.

At first it was contemplated to transfer the magnificent collection of breeding fish to our Eastern stations, but this was found to be impracticable, and instructions were given to plant them in the tributaries of the McCloud River in the vicinity of the station. The number deposited was as follows: 2000 large breeders, 5000 yearlings, and 80,000 fry.

Description of the McCloud Rainbow Trout, Its Habits and Its Abundance

There can be no doubt but what the McCloud rainbow were, and for that matter still are, fine specimens of this species. In order to better understand the rainbow trout of fish culture and to complete the picture of the McCloud River conditions of earlier days, I will present what information we have.

Livingston Stone (1885) spoke of this trout as follows:

Much is said about the red-banded trout of these mountain regions, as if they were a distinct variety of trout from the others; and one often hears sportsmen inquire whether they can catch the red-banded trout at a specified place, as if they thought that the trout with the red band were not only different, but much better than the other trout. This is a mistake. The red band is not a mark of a better variety or a different variety, nor, as far as I have been able to learn, a sign of anything in particular except age. It is a badge of maturity and that is all. It is not found on trout less than a year old, but I think I am authorized to say that it is constant or nearly so in very old trout. At all events, the absence of the band is not known to be a sign of anything except youth, for, if you catch a middle-aged trout with the red band, you may catch another feeding by the side of it, of the same variety, age, sex, and of the same size, which does not have the red band. Neither does the band, nor the absence of the band, appear to be a mark of any special season with the fish, for at all seasons of the year, in the spawning season and out of the spawning season, when prime and when not prime, you will find trout with the red band and trout without it side by side and looking otherwise just alike, and this is true of all ages and of both sexes, except, as just remarked, with trout less than a year old, which never have the red band, and with very old trout, which I think always have it. Perhaps it is also safe to say that the older the trout the more likely it is to have the red band and the more pronounced it is likely to be. I may add here that very old trout have other distinguishing marks. Their heads and shoulders are very large compared with the rest of their bodies. Their bodies are not symmetrical, like those of younger fish, but seem to taper almost steadily from the shoulders to the caudal fin. Their mouths will open much wider than those of young trout, and their tails, when stretched, will be less forked; indeed, in very old trout their tails are almost perfectly square, as it is called, by which is meant that the outline of the caudal fin is at the posterior end, when stretched straight, instead of forked, as it is in young fish. Old fish also have in general a gaunt, ill-favored look, and their flesh is usually a dusky white.

In 1882, Stone made more or less the same remarks on the McCloud rainbow as he did in the foregoing passage but due to some variations, these earlier observations may bear summary. He said that there is great variation in color and shape of the brood fish held at the McCloud ponds and also in their eggs. Some fish were dark and dirty looking while others were plump, bright and had a fine red band. He felt, however, that only one species was present. He saw the apparent difference between the river and stream rainbow but concluded it was an environmental difference. He was undoubtedly right in this belief.

It might be well to include the following short description of *Salmo gairdneri shasta*, as given by Jordan (1894.1), which is the first official description of the McCloud River rainbow as a distinct subspecies.

> Body comparatively short and deep, compressed. Head short, convex, obtusely ridged above. Mouth comparatively small, the broad maxillary scarcely reaching beyond the eye, except in old males; the maxillary is about 1⅔ in head in males, 2 in females. Eye large, about 5 in head. Vomerine teeth in two alternating series; hyoid teeth wanting. Dorsal fins moderate; caudal distinctly lunate or slightly forked. Scales intermediate in size between those of the Coast Range trout *(Salmo gairdneri irideus)* and those of the Cut-throat trout; the usual number of transverse series about 145. Head, 4 in length; depth, 3 4/5. D. 11, A. 10 or 11.
>
> Color greenish above, with bright reflections, silvery below; above everywhere profusely but irregularly spotted; spots present on head; spots on caudal small; belly nearly plain. Males, and usually females, also with a broad red lateral band and red blotches; much red on cheeks and opercles; fins usually not red; usually a trace at least of orange dashes between branches of lower jaw.
>
> This name is given to the trout of the Upper Sacramento, the types having been sent by Mr. Livingston Stone from the United States fish hatchery on the McCloud River at Baird. This form has been largely planted in other streams, both east and west, under the name of Rainbow trout. The name Rainbow trout is a translation of the name *Salmo irideus*, first applied by Dr. Gibbons to trout taken in San Leandro Creek in Alameda County. The name *irideus* belongs, therefore, to the Coast Range trout, which differs slightly from the Shasta trout above described. The scales are larger in *irideus*, usually about 130, and there is no trace of the "cut-throat" marks under the lower jaw. In what degree the two forms intergrade we cannot say as yet, and the present arrangement is only tentative until the various forms of the Rainbow trout are better known. Only a complete survey of the trout-bearing waters of California and neighboring States can give us accurate knowledge of the relationship of the different forms.

At this point we should consider the "No-shee trout" (*Salmo irideus stonei*) which Jordan described as a new subspecies in the same article (1894.1) that contained the above description of *S. gairdnerii shasta*. This fish was known only from a few specimens, though the Indians said they were common eight miles above Baird. It was supposed to differ from the more common form of McCloud rainbow in its coloration, number of scales and teeth. It was also supposed to attain a larger size, even as great as twelve pounds. I have examined the original specimens of *stonei* in the Stanford University collection and believe that if it is not a simple variant of the river population it is a sea-run form or steelhead. The steelhead run in the McCloud was not ordinarily recognized, though Joseph Campbell assures me that he formerly trapped them along with nonmigratory rainbow. A few steelhead ascend the upper Sacramento even today and the run in the Pit River was formerly quite large.

We will not be able to drop the name *stonei* altogether, for if by a genetical study we show the migratory and nonmigratory rainbows to be inherently distinct, we can use *S. gairdnerii shasta* for the original McCloud rainbow of fish culture, but we may have to retain *S. gairdnerii stonei* for the steelhead or migratory rainbow. If a genetical study shows that the migratory and nonmigratory rainbow are variants of the same subspecies we will have to use *S. gairdnerii stonei* for all the McCloud rainbow, discarding *shasta*, as *stonei* has a short priority over *shasta*.

A new brood stock of rainbow trout, which has been started at the Mt. Shasta Hatchery of the California Division of Fish and Game and

FIG. 100. Looking down the McCloud River from the west side below Ellery. Fall, 1938.

which is now four years old, exhibits all of the characteristics of the original McCloud River strain. It is a deep-bodied fish; the females have short heads with round snouts and small mouths, while the males are not as deep bodied in proportion to their length, their heads are larger, the snout sharper and the mouth much larger. The spotting is heavy and usually extends down to but not onto the belly. The color is greenish above, sides dark with a violet to reddish band which is not distinctly marked. The belly is white. In many individuals there is a salmon or orange-colored dash on the branchiostegal membranes. The scale count in four specimens ranged from 120 to 130 in the lateral line

and the vertebral count in two was 59, in one it was 61 and in another the number of vertebrae was 62.

This brood stock was derived largely from the Springville, Utah, strain which Fred J. Foster, of the U. S. Bureau of Fisheries, says came originally from Bourbon, Missouri, in 1931 or 1932. These had been sent shortly after 1920 to Bourbon from Neosho, Missouri. Foster says of these Neosho fish, "There is no telling where the eggs originally came from, but I feel sure that from time to time the original stock was added to by introductions of Northwest Coast steelhead and perhaps wild fish from other sources." This seems quite probable, but I believe that the original stock at Neosho must have been McCloud rainbow by reason of the appearance of the descendants which we have at Mt. Shasta.

It is 15 miles from the Mt. Shasta Hatchery to the McCloud River, from where I believe the ancestors originally came about 55 years ago. They were forced to make a circuitous journey between the two locations but through selection their spawning period was changed from spring to fall, a worthwhile alteration, I believe.

So much for the appearance of the McCloud River rainbow. It is interesting to note the early comments on the habits of this fish. J. B. Campbell (1882), who has been mentioned previously, said that the "red-sided trout" feeds almost entirely on the bottom of the river but takes a fly during March, April and a part of May when the river is literally alive with insects. A favorite food is salmon eggs and the carcasses of dead salmon. During the late summer when these two foods are available the rainbow, or as he called them, "red-sided trout" become very fat and will rarely take a hook. The fish, he said, sometimes run up streams to spawn but usually spawn in the river. Campbell stated that the rainbow were abundant farther up the river under the high falls above the big springs, so abundant that he caught one hundred in less than two hours. These were smaller than the fish farther down, averaging one-half to one pound. He then speaks of the trout above the falls, and if he is correct, I am at a loss to explain the inconsistency in size of fish. He says that the trout above the falls average about eight to ten pounds. I feel he must have meant eight to ten inches for the food supply, without question, was much less above the falls than below. There could have been no fish above the falls but rainbow.

Stone (1885) describes the action of the McCloud rainbow as follows:

> The fishing for parent trout was continued this year, and probably enough were caught to supply this year's waste in the ponds, caused by the various adverse agencies to which trout are exposed, and whose destructive character the trout breeder knows very well.
>
> The fishing was conducted this year on the same general plan as heretofore, viz., by using set-lines stretched from one point to another in the river, and furnished with lateral lines at suitable intervals, to which are attached the hook and bait. These lateral lines extend to the bottom of the river, for unlike eastern trout *(Salvelinus fontinalis)* the McCloud River trout *(Salmo irideus)* feed off the bottom of the stream. Their method of looking for food is peculiar and wholly unlike that of their eastern cousins. Every trout fisherman in the Eastern States has noticed that the speckled *fontinalis* is always looking upwards for food as if expecting, as he really does, that his food will come from above. He is also generally evenly poised in the water and sits in it like a well-trimmed ship on a quiet day at sea. The California trout, on the

contrary, roams about his watery hunting grounds partly on his side with one eye directed to the bottom. He is quite as dependent, and probably more so, upon the supply of food that is beneath as for the supply that falls from above or floats on the surface. Consequently he spends as much of his time looking down for food as he does looking up for it. He has another peculiarity also about feeding: When he sees any food on the bottom that looks to him out of place, or has from any cause a suspicious appearance, he wheels past it, and as he passes the suspicious object he strikes it a vigorous blow with his tail and then turns to observe its movements. If there appears to be anything "crooked" about it he will not touch it, and will, after striking it perhaps once or twice more with his tail, abandon it altogether. This we have occasion to notice very often on our fishing grounds, because before setting the lines at any particular spot we "salt" the ground for two or three days before, by freely strewing bait about the place where the lines are to be set. When the trout first come up and see the bait—usually salmon eggs—scattered about so lavishly, in such an unusual place, they seem to suspect at once that there is something wrong about it, and they knock the eggs about vigorously with their tails and watch the bait very cautiously and suspiciously, and it often happens that they will repeat this a day or two before they will decide to swallow this unexpected but tempting food; and Mr. Green assures me that, unless the trout had had their suspicions set at rest by this false and harmless bait, they sometimes could not be persuaded, except with difficulty, to take the real bait in which is concealed the fatal hook.

It might not be out of place to include here the description of a serious disease which broke out in the rainbow trout kept in the ponds and also those in the river. (Stone, 1889.) The epidemic began in September, 1885, and increased until mid-December, then began to decrease and in February had disappeared. The adult fish grew dark, refused food, and lay quietly on their left sides on the bottom. If disturbed they might swim off as though normal. They would act thus for from three to six days, by which time the gills would become clogged with debris and the fish would die. Some became cramped and their bodies bent. Loren W. Green at the time reported the death of 241 in the ponds and many were seen dying in the river. Six specimens were sent to Prof. S. A. Forbes at Champaign, Illinois, who reported that the kidneys were the principal seat of the disorder. The spleen was considerably affected and the liver less so. In one specimen the heart was examined and also found involved. The kidneys were black and soft. The connective tissue, capillaries, etc., were almost wholly replaced by a mere pulp of pigmented corpuscles, black pigment granules, and micrococci, in which lay embedded vast numbers of spherical corpuscles, each containing an embryo parasite. These encysted parasites were so numerous that the kidney pulp was seen to be everywhere thickly speckled with them.

A further description by Forbes is as follows (taken from Stone, 1889):

The spleen is much pigmented, like the kidneys, but less so, and the liver still less than the spleen, the pigment cells being much the most abundant about the blood-vessels, and often blocking the capillaries, especially in the liver, and causing the degeneration of large tracts of the gland substance. A similar disorganization of the liver cells frequently appears at a distance from arteries or veins. The spleen and liver are free from parasites. On the other hand, my sections of the heart show great numbers of the kidney parasites all through the walls of that organ. I counted thirty-three in a single thin section. A hasty examination of the muscular tissue of the back showed none, and the brain does not contain them.

As matters are, I cannot doubt that these kidney parasites caused the death of these fish. In my previous and first examination of these fish I was

misled by the fact that the first specimens from which sections were obtained contained relatively few of these parasites, while the general appearance of the organs in other respects was closely like that of the diseased herring from Lake Mendota.

Of course, no practical conclusion can be drawn from this until we know what these parasites are and where they came from, or in what other host they continue their development; and for this a general study of the subject on the spot would be necessary.

Green found that there was no loss of fish in one pond which received water separately from the creek and into which pond no river fish had been recently placed. According to the records this disease did not occur again while the ponds were in operation. Although Forbes does not specifically name the organism which he found, I assume from the description that it is a sporozoan.

In addition to the disease just described, I found during this survey in 1938 one six-inch rainbow in the McCloud River with many mussel glochidia attached to the gill filaments. I do not know how extensive this infestation is in the river but we do know from experience on the Truckee River that rainbow can be killed in considerable numbers by these immature mussels. The sand from Mud Creek which has been deposited in the river bed provides a good place for the mussels to grow. Although I searched for adult mussel shells along the river shore I found none and cannot, therefore, identify the species.

I have been informed by a fish hatchery man of the California Division of Fish and Game that he found several rainbow in the lower McCloud with copepods (probably *Salmincola*).

My own observations on the rainbow themselves were rather limited during the summer of 1938. The water in the river below the mouth of Mud Creek was as usual so roily that it was impossible to see fish unless they were within about six inches of the surface. Of course, the tributary streams were clear and rainbow were found in several of them. Information gathered from fishermen, though not consistent, makes it appear that rainbow trout still occur in fairly large numbers. Very few fishermen can be encountered on the river below the falls and it would be necessary to set up a checking station on the road leading away from the lower McCloud before a fair estimate of the catch could be obtained. The fishing is considerably better on the Sacramento River, and as the latter is paralleled by a paved highway it is little wonder that few fishermen try the roily waters of the lower McCloud. Fairly good catches can be made by still fishing with clusters of salmon eggs but the fish are usually less than half a pound in weight. Occasionally a larger fish may be caught. I have a record of a 5-pound, 24-inch rainbow which was caught in 1917. However, a 2-pound rainbow is unusual.

The water is roily throughout the fishing season and few fishermen except the members of the McCloud River Club use flies. The usual method of fishing at present is to sit on a rock and drop a cluster of salmon eggs into a hole and wait. A fairly large proportion of the fish caught this way are 8- to 10-inch Dolly Varden.

Of course all reports are unanimous in saying that the number, size and beauty of the McCloud rainbow was unmatched prior to the heavy mud flows starting about 1922. Expert fly fishermen came from considerable distances to catch them. The fact that two exclusive

fishing clubs purchased large sections of river shore about 1900 indicates that these fish were highly prized. No accurate catch records seem to have been made. The glowing accounts of the fishing before the heavy mud flow are naturally helpful in arriving at an appreciation of the fishing but they are limited as a basis for evaluating the actual production of the river.

Difficult as it is to get a concise picture of fishing before the mud flow, it is even more difficult to make the accounts of the fishing at present agree. In the first place there are fewer people fishing in the river below Mud Creek to furnish data at the present time. The roiliness of the river during most of the fishing season necessitates bait fishing, whereas most of the fishing before the mud flow became serious each summer was largely with flies. These two methods of fishing make it difficult to compare results. When fishing is done in roily water, using a fly, the results are naturally going to be poor. In addition to these points, we have the fact that fishing, even before the river was consistently muddy, was very uncertain. One reliable angler said that before the river became seriously roily the only good months to fish in the river between Big Springs and Squaw Valley Creek were June and from September 15 to November 1. In addition, the fishing was usually much better from 12 noon to 3 p.m. than during the other parts of the day. And, of course, a poor fly fisherman was never sure of getting fish even if he fished during the best times of year and day. What little information is available indicates that this same uncertainty prevails today and that fishing is still better from 12 noon to 3 p.m. than at other hours. We can see, therefore, that unless a fly fisherman fished during the late part of the season when the water had cleared partially, unless he fished during the early afternoon, and unless he was an expert, he should not expect to make good catches at the present time despite the fact that the fish are there. Those who fish in the section of the river mentioned above and who do not fish at the right time of day or who are not expert, naturally catch few, if any, fish, and would be quite naturally inclined to blame the mud flow for having killed the fish or at least forced them to leave the river. There is a very good chance that the heaviest flow of mud which occurred in 1924 may have upset conditions for the fish and for their food very materially. It may well have forced the fish to seek refuge in tributary streams or in the immediate effluent of such streams and it may have pushed many rainbow out into the Pit River. It quite probably destroyed much of the bottom food in the river and rather permanently covered the productive food areas of the river bottom. However, we know that upon the return of satisfactory conditions for fish and fish food, a stream will rehabilitate itself quite rapidly. It is not surprising, therefore, that in view of the past seven years of reasonably healthful trout conditions in the river below Mud Creek, expert fly fishermen can go a few miles below Mud Creek in late October, when the visibility is about four feet, and during the early afternoon make very satisfactory catches of perhaps twelve fish, ranging in size from one-half to one pound. Catches of this sort compare favorably with those possible in the better trout streams of the State but, unfortunately, such catches are rarely made because of the very restricted period of the year when the river water clears sufficiently, and because the major part of the

river below Big Springs is privately controlled and seldom fished in the latter part of the season. If the flow of Mud Creek were diverted or stopped naturally, the water open to the public, below the McCloud Country Club property on the east side of the river and below the Bollibokka Club property on the west side, would furnish very good fishing to those who know how to make the best of their opportunity.

Comparison of my observations with early reports indicates that there is little or no difference in the appearance of the rainbow trout now and before the mud flows. While the water is very roily the fish tend to become a little more silvery, the black spotting and the red band fading somewhat.

In conclusion, we must say that although the trout population is probably not as great now as it was before the mud flows, still the river has a reasonably good number of fish which would furnish good fishing if the water were not roily for the major portion of the open season.

Fish Other Than Rainbow Trout in the McCloud

Mention has previously been made of the large runs of king salmon (*Oncorhynchus tschawytscha*) which formerly made their way from the ocean up the Sacramento River to the Pit and up the Pit to the McCloud. Large numbers of salmon formerly went as far up the McCloud as the lower falls, where they were stopped. They spawned in the river and in the tributary streams. A few still ascend the river each year but the huge runs of former years have long been ended. Commercial fishing caused most of the depletion. The hatchery racks at Baird formerly let many fish through, but in more recent years all the salmon were stopped by the racks and spawned artificially. Since the racks were permanently removed a few years ago the stragglers which still enter the McCloud can continue on up the river. The salmon and the Wyntoon Indians, once abundant, are now almost gone. The Indians, though disappearing rapidly, will probably be represented by a few scattered individuals along the river after the salmon have been shut off completely by the new Shasta Dam which is being built a few miles below.

As the Sacramento salmon run has beeen treated previously by Clark (1929) of the California Division of Fish and Game, and others, and as a special crew of investigators engaged by the U. S. Bureau of Fisheries is at present studying the salmon run in the Upper Sacramento drainage, I have not paid special attention to these fish.

Another member of the family Salmonidae and one which has been mentioned previously in this paper is the Dolly Varden trout. Jordan (1894.2) told of the christening of *Salvelinus malma* as follows:

> In Oregon the red-spotted trout, or charr, is distinguished by the name of Bull Trout. In California it had, for a long time, no distinctive name. The landlady at the hotel at the Upper Soda Springs, at the time of the Dolly Varden craze, noticing the gaudy colors of this California charr, proposed to call it the Dolly Varden trout. This name coming to the notice of Professor Baird, then United States Fish Commissioner, pleased his fancy. At that time I was in Washington engaged in the classification of the trout in the Smithsonian Institution. Professor Baird asked me to give the species the common name of Dolly Varden trout, and so, in the books at least, Dolly Varden trout it is to this day.

In 1939 the writer was told by Mrs. Elda Masson of Upper Soda Springs near Dunsmuir on the Sacramento River that she, as a girl of about ten, gave the name Dolly Varden to this fish because she had recently been reading Charles Dickens' "Barnaby Rudge" in which there is a character named Dolly Varden. Mrs. Masson said that she was unaware of actress Dolly Varden and the cloth with red dots named for her. It now appears that it was not the landlady who gave the name but her daughter and that the fish is named not for a cloth but for a character in the aforementioned book.

Mrs. Masson assured the writer that a few Dolly Varden formerly occurred in the upper Sacramento River in the vicinity of Dunsmuir. These have apparently all disappeared.

S. malma was supposedly less abundant toward the mouth of the McCloud, though I was told by one fisherman that he had caught them in the Pit River near the mouth of Squaw Creek. They range nearly up to the lower falls at present and seem to be common throughout most of this range. The size of those caught is usually between 8 and 10 inches, although reports are heard of them reaching a weight of 16 pounds, even at the present time. It is their habit to frequent the deeper pools. They are notably omnivorous, feeding on fish, amphibians and mice among the other more common trout foods. A lure which is supposed to be very effective is a live mouse. The mouse is placed on a block of wood and floated out over a deep pool, then pulled off the block. At the present time the "Dollies" are generally disliked by the fishermen who can differentiate them from the occasional Loch Leven trout found on the lower McCloud and from the rainbow. Stone, however, reported them to be highly prized as food in the earlier days. He said that parties would travel fifteen miles by trail from the resort at Upper Soda Springs on the Sacramento River to the McCloud River simply to catch the Dolly Varden.

An interesting point in connection with the Dolly Varden is that Stone says that the Indians called this fish *Wyc-dar-deckit*, or trout of the north. Stone believed that north referred to the northern headwaters of the river where this fish was more abundant. However, I feel reasonably sure that the Indians meant Oregon, Washington and other points north of the McCloud River where we know the Dolly Varden to be much more plentiful and widely dispersed.

Stone believed the spawning time to be about September and J. B. Campbell said it was from September to November. He also said that the Dolly Varden eggs were about one-half the size of rainbow eggs or about 500 to 550 per ounce.

There is no bag limit on this trout but the writer does not feel that it is in any danger of extinction despite its limited range. It seems to some ardent rainbow enthusiasts that the Dolly Varden is a cannibalistic undesirable, but to others it is more of a colorful remnant of a vanishing species, vanishing at least insofar as California is concerned. The fact that this fish, which is so abundant northward, is not found elsewhere in the State, presents a baffling problem in ecology and one which adds greatly to its romance. Of course, a vanishing species is one which for some reason or reasons finds life impossible in an area, and as it slowly loses its foothold in stream after stream it must

eventually become relegated to one body of water and from which it will probably some day disappear altogether.

Although the occurrence of Loch Leven and brook trout is noted elsewhere in this paper it would be well to speak at this point of their occurrence in the river system as a whole.

The Loch Leven or brown trout (*Salmo fario*) has been planted in large numbers in the river, especially in the upper section. It occurs more abundantly than either rainbow or brook trout in this upper section above the big springs and it also occurs to some extent in the lower river, especially toward the mouth in the region eventually to be part of the Shasta Reservoir.

The brook trout (*Salvelinus fontinalis*) is found in the upper river and in the tributaries of this upper section. It does not appear to be as widely dispersed in this area, seeming to find but a few spots where it will do well.

We have nothing to fear from the brook trout, but the brown or Loch Leven, inferior in many ways to the rainbow, has already displaced the latter in many areas and may well continue to displace it throughout the entire river system.

The writer found two small populations of southern Sierra golden trout, probably *Salmo aqua-bonita*, in tributaries near the head of the McCloud. These will be mentioned later in discussing the streams of this river system. It should be noted here that we have no record of these fish being planted in the McCloud, but a former employee at the Mt. Shasta Hatchery said that he could recall a few golden being planted in this section about 18 years ago. One of the two groups of golden trout occurs as a pure population; the other becomes mixed with rainbow in the lower section of the stream. They are the only representatives of this species in the northern section of the State, so far as the writer is aware.

In addition to the members of the family Salmonidae found in the river, we know of the occurrence of four other fish and suspect the presence of three more. Those which we know are present in the McCloud are: *Ptychocheilus grandis*, the Sacramento pike or squawfish; *Mylopharodon conocephalus*, the blackfish or chub; *Catostomus occidentalis*, the sucker; and *Cottus shasta*, the bullhead. The validity of the specific name of this last fish is questionable. The three which are suspected of being present are: *Hesperoleucus symmetricus*, *Apocope sp.?* and *Hysterocarpus traski*, the fresh-water viviparous perch.

The exact ranges of all these species are not known. During the summer's observations in 1938 little information was gathered relative to this problem. The river water was so roily that few fish of any kind could be seen and the volume and speed of the water were too great to permit one man to do any seining.

It is interesting that most of our published data on the "rough fish" of the McCloud were taken by J. B. Campbell, who very evidently was interested in everything pertaining to fish. His notes (1882) describe the "rifle pike" apparently *Mylopharodon*, as being excellent for food, occurring in the lowest four miles of the river and weighing from two to five pounds. The "white fish," *Ptychocheilus*, he describes as a splendid fish, white-fleshed, preferring sluggish water, occurring as far as 12 miles from the mouth, and weighing from 4 to 28 pounds. The

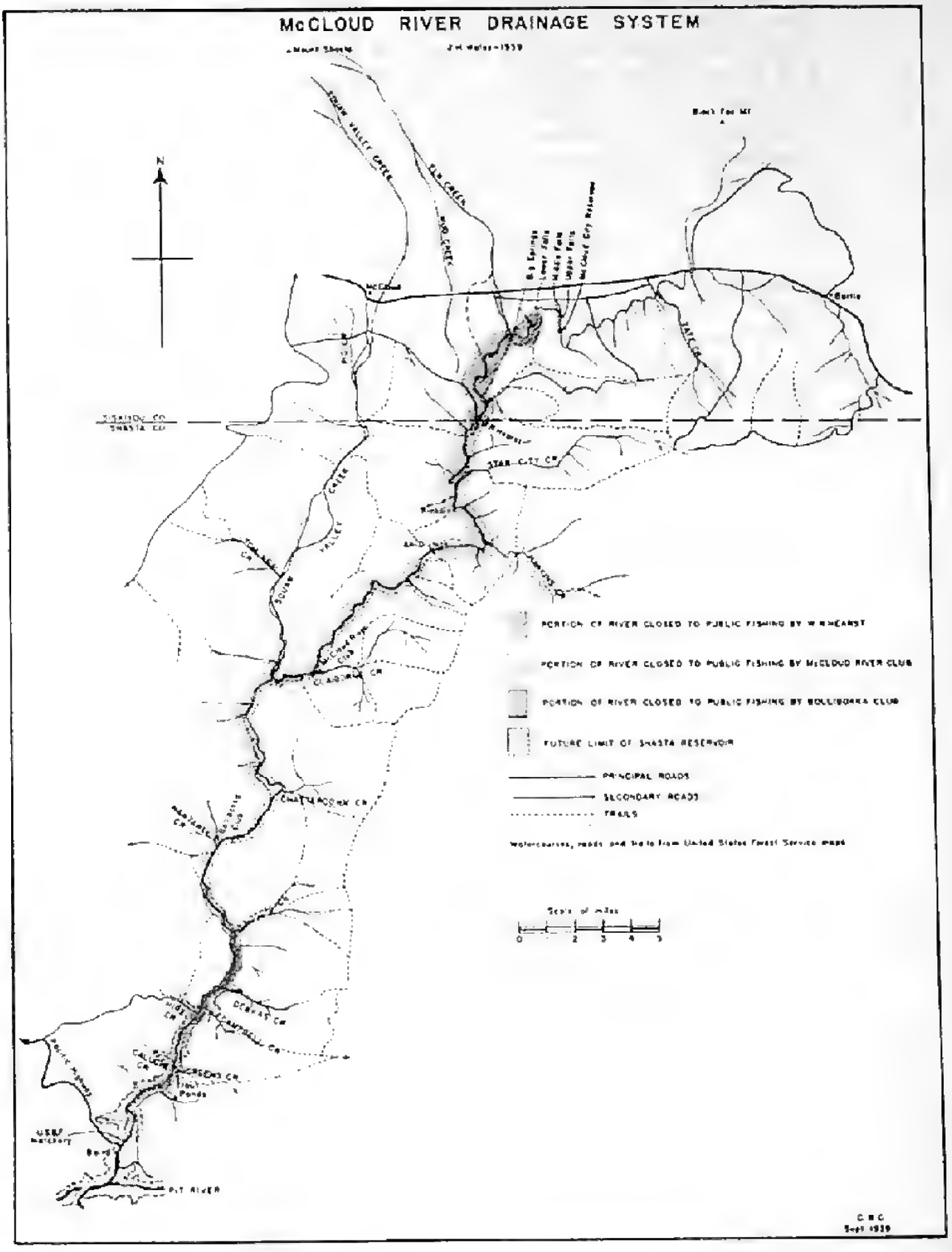

FIG. 101. Map of the McCloud River and tributaries. Blue shaded area shows the future limit of Shasta Reservoir. Black shaded areas show portions of the river closed to public fishing. It should be noted that not all the river flowing through the Hearst property is closed to fishing. Mr. Hearst allows fishing in some places and there are small areas of National Forest land scattered along the river. Although the Bollibokka Club owns the land on both sides of the river, public fishing is permitted on the east side.

sucker, he said, inhabited the lower 12 or 14 miles of river, and though averaging one pound, reaches a weight of five pounds. The bullhead, Campbell said, measures from one to three inches and is very destructive to salmon spawn and newly hatched fry. These cottoids are frequently taken while fishing with single salmon eggs.

I observed yearling rainbow feeding on minnow fry, probably young pike, in Nosoni Creek in July. The temperature of the creek was 65° F. whereas the river at the time was 58°.

Private Holdings on the McCloud River

Before starting a description of the physiographical and biological features of the river and its tributaries, we might consider briefly the private property on the river where public fishing is prohibited.

There is no river in the State where as great a percentage of the water is closed to the public. There are three separate interests which together control approximately 69 per cent of the river from Lower Falls to the mouth.

As shown on the map, William Randolph Hearst owns both sides of the river from Lower Falls to Ah-di-nah, a distance of about 15 miles. At present there are some sections of National Forest land between the above points, thus reducing the total length of river controlled by Mr. Hearst to approximately 12¼ miles.

No attempt has been made in the past to prohibit fishing between Lower Falls and the mouth of Elk Creek (Mud Creek water) and even a little below. Thus fishing is actually restricted in only about 10¼ miles within the borders of the Hearst property. However, the pieces of National Forest land between Lower Falls and Ah-di-nah are so located that one has considerable difficulty in reaching them without crossing private property.

The amount of fishing in the river flowing through the Hearst property is very small. Considering the area of trout water in this section there are few streams in the State which have less fishing.

Below the Hearst property, and adjoining it near Ah-di-nah, lies the McCloud River Club which embraces eight miles of the river on both sides. Only members and guests are permitted to fish in this section of the river. The members are strict fly fishermen and the number of active members which fished the river during the 1938 season was authoritatively estimated at ten. Considering the fact that these men use flies in this section of the river during the season of the year when the river is roily, and considering the large area of the club property, one realizes that the number of fish removed must be relatively small.

Adjoining the McCloud River Club on the south is the Bollibokka Club, which extends down river to a point about one mile below the mouth of Nawtawakit Creek, which is near the end of the McCloud River Road. Only members and guests are permitted to fish on the west side within the limits of the club property. It is difficult to cross the river except by boat and, consequently, there is very little fishing on the east side in the Bollibokka Club property. There is some fishing on the east side of the river below the club, but by far the heaviest fishing on the lower McCloud is on the west side from the Bollibokka Club to the river's mouth, a distance of about 16 miles. The upper

half of this area is accessible by the McCloud River Road which leaves the Pacific Highway at Salt Creek.

The lowest mile and a half of the river parallels the Pacific Highway. A small spur leads up the river about two miles to several summer cottages on the west side of the river. Therefore, there is considerable fishing in the lowest five miles, and then above in the river where it is paralleled by the McCloud River Road there is also considerable fishing. Even in these two areas there is little fishing on the east side.

It is evident from this summary that there is relatively little fishing in the lower 47 miles of the river.

Description of the McCloud River and Its Principal Tributaries

The river is composed of one main stem, one large tributary stream and approximately 30 smaller tributaries which are over a mile in length. The large tributary is Squaw Valley Creek, which heads on Mt. Shasta and enters the river 27 miles from its mouth. The length of the river is approximately 70 miles from the Pit River, where the elevation is about 700 feet to its head, where the elevation is about 5000 feet. The river is fairly well divided into an upper and a lower section by the presence of two large springs which are located on the north edge of the river, approximately 49 miles from the mouth. In the summer of 1938, when the flow of the river above the springs was relatively low, I estimated roughly that the amount of water entering from both the springs combined was twice the volume in the river above the springs. About two miles below the Big Springs is a U. S. Geological Survey gauging station. About one and a half miles from the junction of the McCloud River with the Pit is another gauging station. The pertinent data from the 1936 U. S. Geological Survey water supply paper is given below:

McCloud River below Big Springs

- Altitude: 2750 feet
- Drainage area: 388 square miles
- Maximum discharge during 1936: 2570 sec. ft. on February 22, 1936
- Minimum discharge during 1936: 526 sec. ft. on December 16-25 and February 8-10
- Maximum discharge between 1931-36: 2570 sec. ft. on February 22, 1936
- Minimum discharge between 1931-36: 524 sec. ft. on November 23, 24, 1932
- Runoff in acre ft. for water year 1935-36: 492,800

McCloud River at Baird, 1½ miles from junction with Pit River

- Altitude: about 700 ft.
- Drainage area: 668 square miles
- Maximum discharge during 1936: 25,900 sec. ft. on February 21, 1936
- Minimum discharge during 1936: 705 sec. ft. on November 29-December 5
- Maximum discharge between 1910-36: 27,600 sec. ft. on February 2, 1917
- Minimum discharge between 1910-36: 650 sec. ft. in August-October, 1931
- Average discharge from 1911-36: 1637 sec. ft.
- Runoff in acre ft. for year 1935-36: 1,062,000

From these data we see that the two big springs contribute approximately 450 second feet, which is considerably over half the minimum flow at Baird. This unusually large flow of water of constant volume and constant temperature naturally makes the river ideal for trout. The temperature of the spring water runs around 44° to 45° F., while the river at Baird varies from about 42° to 62° F.

About one mile above upper Big Springs is the lowest of three falls on the river. The height of this natural fall over a lava rock ledge is about 20 feet. Within the two miles above the falls are two more natural falls, about 40 and 30 feet high, respectively. Above the upper falls about one-quarter mile are a dam and small reservoir from which the town of McCloud gets its water supply.

FIG. 102. Lower Falls, McCloud River. Fall, 1938.

These falls are all much too high for salmon or trout to ascend and in the past they played quite a part in separating the river into two sections in respect to the fish. At present, with only a relatively small salmon run, the Big Springs are more important as an ecological barrier. Above the springs the flow, as I have already indicated, is small—little more in summer than a moderate creek—with a temperature varying with the air from near freezing to perhaps 60° or even higher. A few years ago during a particularly dry spell, the river above the springs actually became intermittent and fish were stranded. The gradient is moderate from the falls almost to the head of the river where there is a sudden ascent. For the most part the upper section

of river is a series of quiet stretches and gentle riffles, and although the volume of water is small, it is excellent trout water, especially for Loch Leven. Before the introduction of Loch Leven, rainbow undoubtedly found this suitable water, but where Loch Leven find conditions equally as suitable as do the rainbow the balance generally tips in favor of the Loch Leven. Along the south side of the upper section of river rises

FIG. 103. McCloud River above Lower Falls. January, 1939.

a range of rugged, timber-covered mountains which separates the McCloud drainage from the Pit. Down the canyons in this range flow several moderate tributaries but on the north side of the river is a lava plateau, covered with timber but almost free from canyons and tributary streams. The banks of the upper section of the McCloud are fairly well timbered and along the very edge of the water is a fringe of willows. There is very little aquatic plant growth and the bottom is broken by stretches of silt in the quiet areas, by scattered lava rocks, by gentle series of lava pools and by riffles of lava gravel. Although Loch Leven predominate, rainbow and brook trout find this quite suitable. In this upper section are several spring runs where natural propagation is possible. The Loch Leven find these gentle flowing, cress-filled runs very suitable for spawning.

Between Big Springs and the head there is only one large tributary stream. This is Tate Creek, at present closed to fishing. Loch Leven are very abundant in Tate Creek, natural propagation is good and there is little doubt but what the stream acts somewhat as a nursery stream for the river. Just how valuable a closed stream such as this

is to the river, I cannot say. There is some reason to believe that fish do not move out of a tributary stream such as this but remain to spawn and eventually reach a maximum density where cannibalism checks further increase. If this is more than a possibility, there is little justification for closed streams. Considerable work needs to be done on this problem. In the headwaters, Tate Creek is a steep, rough little stream with a rocky, gravelly bottom, sheltered by thick fringes of willow. There is a moderate supply of food although there are no aquatic plants. The temperature probably ranges between 32° and 50° F. At an altitude of about 4500 to 5000 feet is a population of southern Sierra golden trout which was mentioned previously. About ten miles directly north of this, on the opposite side of the McCloud River is Black Fox Mountain, on whose slopes is a short spring run

FIG. 104. The McCloud River near Bigelow Meadow crossing, during the low water of November, 1937.

of about three-quarters of a mile. This run is connected with the river for short intervals in years of unusually heavy rainfall. In the run is another population of golden trout. This short stream is quite different from the head of Tate Creek. The flow is much smaller, the temperature is about 50° F. and the bottom is largely silt-covered. There are numerous small pools and much fallen cover. Part of it is

open and part is very brushy. The altitude is around 4500 feet and the slope of the stream is moderately abrupt. As I said before, the fish here are true golden trout but more nearly resemble the color variation described in the past as *Salmo roosevelti*. The population when I found it was heavy and the fish were apparently stunted by lack of food to about a seven-inch maximum.

By way of summary, we see that the upper 20 miles of the McCloud River above Big Springs is a relatively small, fairly quiet stream—rocky in part and with long quiet stretches thickly bordered by willows. Occasional small springs flow a short distance and enter the river. The largest tributary is Tate Creek which at the mouth is 12 to 15 feet wide and 6 to 8 inches deep during early fall. It is fairly rapid, clear, and in September the temperature was about 45°. The bottom is coarse gravel and the banks are thickly overhung with willows and alders. This creek, of course, rises to several times its low water volume during the winter rains and early spring thaw.

The entire river remains free of ice in the winter, though the upper section at about 3000 feet elevation or higher receives considerable snow, amounting in some years to about five feet.

In the upper McCloud we find numerous American mergansers, blue herons and occasional bitterns, which undoubtedly take a great many trout as there are no other fish to supplement their diet. These birds are present in the lower McCloud as well but the wading birds have little opportunity to fish except in the tributaries.

The Loch Leven are more abundant in the McCloud River above Big Springs than either brook or rainbow. Not only is this section suited to Loch Leven, but it has been heavily planted with this species from the Mt. Shasta Hatchery. From 1931 to 1938, inclusive, 779,700 Loch Leven fingerlings, 610,000 rainbow fingerlings, 300,000 brook fingerlings and 1250 three-year-old brook were placed in the upper McCloud. This is, of course, very heavy planting for such a stream. Although this section of the river is fished more heavily than the lower river, nevertheless the amount of fishing is not heavy compared to many other streams in the State. In addition, there is considerable natural propagation in the river, especially in the upper section.

The Big Springs change the appearance of the river in many ways, as already stated. Between Big Springs and the entrance of Elk Creek (until the summer of 1938, Mud Creek water flowed down the Elk Creek channel) is a distance of a little over a mile. We have here a small sample of the river as it was before the glacial silt brought about its several changes. The water in this short section is crystal clear except when the upper McCloud is at high-water stage. The river bed is entirely free from the sand which mars the beauty of the river below. The clean lava rocks, whether protruding or beneath the surface, are sharply visible and are more or less covered with bright green watercress (*Radicula sinuata?*). The river here is about 55 feet wide, three to four feet deep and swift. The cress seems to grow as well in this swift, buffeting water with a temperature of 45° F. as its near relatives do in quiet spring runs. May fly and stone fly nymphs are abundant in the cress though no scuds were found. The deep, swift water and the numerous lava rocks and boulders afford ample shelter for the fish. Although this section of the river is in Hearst's estate it is open to

fishing at the present time. It is rather heavily fished but many rainbow are still present because the unusually clear water requires more skill than most anglers possess.

This general discussion of the river has brought us as far down as the present entrance of the Mud Creek water which changed its course during 1938 and now enters the river about one-quarter of a mile below lower Big Springs, instead of at Elk Creek, which enters the McCloud about one mile farther down. With small expense it is said that the Mud Creek water could be diverted back into Elk Creek and a mile of the river returned to its former state.

It was estimated that in 1924 Mud Creek deposited 10,000,000 cubic yards of glacial debris from the Mud Creek canyon on the southeast side of Mt. Shasta, between the mouth of the canyon and the McCloud River, a distance of about ten miles, and an undetermined amount entered the river. In 1926 there occurred another heavy "mud" flow but not as bad as in 1924. In 1931 [2] Walter Ruppel determined that about 5,000,000 cubic yards of sand were deposited above the gauging station which was operated from 1927 to 1933. This station was located on Elk Creek, about four miles from the river. Therefore, we may assume that 1931, although a year of heavy mud flow, was not as bad as 1924. Mr. Ruppel said, "At times during these years the mud flow reached the consistency of thick gruel, just enough water to lubricate the mass."

Other eye witnesses have told me that huge boulders washed into the mud flow would not roll along the bottom as in clear water but would bob up and down through the thick mass, indicating that the flow itself was almost as heavy as the rock. Of course, most of the sand was deposited before it reached the river; had it not been so the river would have been filled completely by the debris. Nevertheless, a great amount of material did enter the river, just how much the data do not indicate. The volume of the solid content of Elk Creek during July, 1932, was 130,000 cubic yards or 8.8 per cent of the Elk Creek water. The content of solids in the McCloud River during July, 1932, was probably about 0.2 per cent. In 1932 Ruppel estimated that the solid content of Elk Creek water was over 50 per cent of that in 1931. Therefore, the McCloud River's solid content would have been close to 0.4 per cent in the worst month of 1931, had it not been that from 1927 to 1932 most of the solids were settled out in basins and check dams designed by Ruppel. As stated previously, the deposit of sand between the mouth of Mud Creek gorge and the river was approximately 10,000,000 cubic yards in 1924. In 1931, approximately 5,000,000 cubic yards were deposited above the gauging station. As more sand is deposited above than below the gauging station, we are safe in assuming that 7,000,000 cubic yards were deposited above the location of the gauging station in 1924. This would mean that the mud content of the Elk Creek water entering the McCloud River during the worst of the flow in 1931 was about five-sevenths that of 1924, making the solids content of the McCloud River water about 0.65 per cent during the worst of the flow in 1924. Of course, most of this solid material is sand which is swept along the bottom more than it is carried high in the

[2] Unpublished data furnished through the courtesy of Mr. Ruppel, Civil Engineer, San Francisco.

water. Therefore, it is impossible to estimate the quantity of the inorganic particles which actually contacted the fish.

There are many tributary streams entering the river throughout its length, but with the exception of Squaw Valley Creek they are all too small to accommodate many large trout. It seems very probable that when an unbearable concentration of debris was reached during the worst "flows" the fish either went downstream into the Pit River or went up side streams. No doubt many fish did seek shelter in the tributary streams during the worst periods and then returned to the McCloud in the fall as the silt abated. However, there were at least three months, July, August and September, when the flow must have been unbearable, at least in 1924. Fish which entered the small, shallow, relatively shelterless side streams containing a relatively small amount of food, were in a bad position to survive. The mortality of large fish of two or more pounds would necessarily be high under these conditions. Without doubt many fish survived the worst flow periods and returned to the river. In moderate years, such as the last five, the river water below Mud Creek was not conducive to good trout production but it was not directly harmful to the fish through abrasion. The visibility in the river from June to the middle of October was not over a foot. Samples of the water taken at these times remained murky for weeks after the visible particles had settled out. This situation affects fly fishing seriously. In fact, it is all but impossible to take fish on a dry fly with water so roily and very nearly impossible even with a wet fly.

From 1927 to 1933 sport fishing interests on the river financed a costly project to settle out the mud from Mud Creek in huge basins. This was possible to do but the basins were filled so quickly that the method was given up because of expense. In 1936 the U. S. Forest Service financed a large diversion dam and settling basin and canal whereby it was hoped that most of the sand could be removed and the water diverted onto the flat areas east of Mud Creek, where it would sink into the ground and lose its fine silt load. This method can take care of a part of the flow at least in normal years, but it is admitted that it is not adequate in times of high water. During 1938 the system was out of commission, but with moderate repairs it should tend to alleviate the situation and make possible a gradual improvement of the trout crop in the McCloud, and certainly will improve the fly fishing. Of course, unusually dry winters and hot summers will cause more heavy mud flows and may seriously damage the trout population again.

Not only is the "mud" harmful to the fish by abrading them but it covers up food-producing river bottom. The heavy rains in the winter of 1936-37 helped remove a large part of the sand which had accumulated on the river bottom. The sand was either deposited on the banks above normal water line or carried into the Pit and Sacramento rivers. Despite this cleaning, I estimated in the summer of 1938 that about one-third of the river's bottom, from Mud Creek to the mouth, was covered by sand. This prevents food or at least food for adult fish, from developing on one-third of the bottom area. This reduction of available aquatic food, plus the absence of salmon eggs and salmon carcasses from the heavy runs of these fish as in former years, account in a large way for the inability of the trout population

to return to its position of earlier years. The poor visibility of the water throughout the warmer season when the trout are feeding most heavily may well prevent the fish from obtaining as much food as was possible in the crystal-clear water previous to the heavy mud flow years. Of course, there probably has been a little roily water from Mud Creek in occasional years since time immemorial. Livingston Stone said in his reports between 1872 and 1877 that the river was crystal-clear all year round, but in 1878 he said that from August 10th to 24th the water became roily and his men suspected Chinamen mining upstream, but were later informed that this was a frequent

FIG. 105. Looking up the McCloud River, just above Rinkel's on the Hearst estate. Summer, 1938.

occurrence and caused by Mud Creek. The late E. V. Cassell, superintendent of the Mt. Shasta Hatchery and for several seasons at Baird Hatchery between 1903 and 1910, said that each summer there would be a few weeks when the water was roily but the remainder of the time it was clear and fly fishing was excellent. Large catches of one- to three-pound rainbow could be made by proficient fly casters.

At Upper Falls the river enters a moderately deep canyon from which it does not emerge until it enters the Pit. It is a continuously mountainous area for this distance with the canyon being particularly abrupt from Hearst's to near the McCloud River Club. It is an area

of great natural beauty, unmarred by evidences of man. The steep canyon sides are well timbered by pines, firs and cedars; especially is this true on the Hearst property where there has been no lumbering. Yew trees are abundant in some sections along the water, occasionally reaching a foot and a half in diameter. It was from these yews that the Wyntoon Indians made their bows, surfacing them on the back side with salmon skin to give them greater elasticity.

Below Rinkel's cabin for a few miles the river drops swiftly in an almost continuous rapid. In several places, moss-covered cliffs rise straight from the water. The river's course is very crooked as it winds its way through the steep mountains. Into the river at this section, flow Star City and Hawkins creeks. The former rises in ponds covered by yellow water lilies in a beautiful meadow at 5400 feet. The name Star City arose from a projected coal mine town at the meadow, but neither the town nor the diggings progressed very far. Both creeks are relatively large by the time they reach the McCloud. Star City Creek in September was 10 to 25 feet wide and two to three feet deep at the lower end. Its drop is surprisingly gentle in the lower section, but evidence showed that in the previous two winters the water had risen about six feet. Very few trout were seen in this section, and as fishing could not be heavy the supposition is that the torrential waters destroy the food and shelter. I believe it probable that in early days this creek might have been a favorite with spawning salmon. The water is ample for them and the long gravel riffles would be ideal.

Hawkins Creek in November had a flow of about 12 second feet near the mouth. Its temperature was 41° with the air about the same. Apparently its volume does not increase disproportionately during rain. It is much steeper and more rugged than Star City. Fine pools lie between rapids and low falls. No aquatics were present in the lower mile and a half. Food should be fairly abundant and I saw several four- to six-inch rainbow in the pools.

There are several smaller streams between Hearst's and the McCloud River Club in addition to the two just described. Rainbow are apparently the only fish in these creeks. They are, however, not abundant. I doubt if they play an appreciable role as nursery streams for the river. However, this part of the river, as already stated, is controlled by private interests and the amount of fishing is small.

By the time we reach Claiborne Creek, which enters the river at the McCloud River Club, we find a striking change in the life zone indicators. On the higher canyon sides we, of course, find the typical Sierra Transition trees, but down near the river are many black oaks and maples. A very conspicuous plant which grows along the water's edge from the falls clear to the mouth is the elephant ear or Indian rhubarb (*Peltiphyllum peltatum*). This is common on all the streams in this section of the Sacramento drainage lying below about 2700 feet. The Indians considered the petioles very good eating.

The river valley is broader from Claiborne Creek to the mouth than it is above. The river itself is much slower and for the most part there is more or less of a shelf on both sides of the river which is frequently below high water mark. These lower shelves are covered

with sand which was brought down from Mud Creek. The higher shelves are covered with grass and dotted with oaks.

Claiborne Creek is the largest between Hawkins and Squaw Valley Creek. Its temperature on September 8 was 55°. It is a rugged stream with considerable drop, many rapids and short falls. There are many fine pools and much shelter. About four miles up the main fork is a fall with a sheer drop of about 15 feet which undoubtedly bars the ascent of all migrating fish. However, above the falls are many fine rainbow six to eight inches in length, which resemble the McCloud River fish in shape and color. It is believed that these fish were not planted where they are but have existed above the falls for a great length of time. We would, therefore, have ideal conditions for producing a relatively nonmigratory strain of rainbow, and, consequently, a strain admirably suited for plants in streams where downward migration was possible but undesirable. Theoretically, the progeny of these rainbow above the falls, which might have the characteristic rainbow tendency to migrate downstream into a larger river, lake or the ocean, would in so doing go over the falls and never return. By inbreeding for countless centuries the fish above the falls should have lost all or most of that migratory habit and should, therefore, be admirable for a hatchery brood stock.

Claiborne Creek was known to the Wyntoon Indians as *Soolothaltas*; literally this name meant "trout-going" or "place where the trout go." Joseph Campbell, guide at the McCloud River Club, which is located at Claiborne Creek, said that about 45 years ago he operated a large trap on this creek for rainbow egg-collecting. He said that the run of fish on the creek was particularly heavy.

About two miles below Claiborne Creek is the mouth of Squaw Valley Creek, the largest tributary to the river. This stream is about 26 miles long, heading well up on Mt. Shasta, flowing down through the town of McCloud, and through Squaw Valley. This valley is relatively broad for a few miles south of the town of McCloud but then narrows down and for the last 10 miles is a steep-sided canyon similar to the McCloud River canyon. Squaw Valley Creek receives about five moderate sized tributaries, of which Tom Neal is probably the largest. Despite the fact that it heads on Mt. Shasta very near to the destructive Mud Creek gorge, it does not carry an appreciable quantity of sand and silt. In the broad valley just south of the town the creek and its tributaries, Pig Creek and Soda Springs Creek, have good populations of Loch Leven and brook trout. Numbers of 10- to 12-inch fish of these species were seen in the early fall. About five miles below the town of McCloud, the road which parallels the creek for most of its length is controlled by a locked gate during the summer and at no time is it a public road. It was built by the McCloud River Club and is maintained by the Forest Service for use in controlling fires. It is also used by the few persons owning property along it. This road follows the creek to the McCloud, then up the river about two miles to the McCloud River Club, where it ends. Public fishing is not permitted in the creek below the locked gate. It is, therefore, not heavily fished. The McCloud River Club owns the lower section and members fish in it to some extent. In the lower section the creek is quite large, 15 to 30 feet wide and one to three feet deep, for the most

part. It is very pretty, especially in the lower region. The canyon walls are quite steep, though there are numerous shelves; the area is well wooded with conifers and oaks and the stream edge is lined with large-leafed Indian rhubarb. The course of the stream is moderately steep, there are numerous riffles and many fine, relatively quiet stretches. The lower 10 miles is a fine rainbow stream and it is to be hoped that Loch Leven do not invade it. Members of the McCloud River Club told me that they saw a few salmon in the creek in September, 1938.

The next large tributary to the McCloud below Squaw Valley is Chatterdown. This is a very beautiful stream and embodies the characteristics of the other creeks below. At the mouth it is about 10 to 15 feet wide and 6 to 12 inches deep except in the pools, which are much deeper. The stream bed is very rough, broken by moderate to large rocks and boulders. The temperature on August 25 was 59° at 3 p.m., with the air at 80°. The water is largely overhung by alders and some yews. Conifers are abundant on the slopes. As a whole, the stream is too rocky for best production. In fact, I saw remarkably few fish though I went up all three of the branches. I found an eight-inch and three fingerling rainbow. Another feature which might account in part for the scarcity of young trout was the absence of young minnows of which I saw so many in Nosoni Creek below. In the south fork I found blue-green algae growing abundantly on the rocks, whereas in the other two branches I found none. The temperature was no different in the branches nor were the other discernible factors. Possibly some chemical, leached from an outcropping, made possible the growth.

My impression was that Chatterdown Creek did not contain as many fish as should be expected. Although the lower section of it is in Bollibokka Club property, I doubt if it is fished heavily. I feel reasonably certain that Nosoni is fished more heavily and yet the latter has many rainbow. This contrast between the lower McCloud streams is very interesting and we must know what factors bring about such differences before we can properly manage any streams.

The aspect of the McCloud River and its canyon varies but little from Chatterdown to the Pit River. The surrounding mountains become lower as we go downstream and the conifers gradually give way to oaks until in the last few miles of the river we see little but oaks and digger pines. The 1000-foot contour line crosses the river about five miles below Chatterdown. The tip of the McCloud arm of the future Shasta Reservoir will be about this point. During the winter there is seldom any snow this far down though occasionally there is a light fall. Rainfall in this section is heavy; the tributary streams are evidence of this, and the effect of these downpours on the trout ponds at Greens Creek was partly the reason for the U. S. Bureau of Fisheries giving up the venture. In summer the weather is quite warm and the river itself reaches about 62° F. The current in the river is fairly swift even in this section and there are occasional small rapids. There are many sandy beaches and there are also several points where high cliffs rise abruptly from the river. Some spectacular granite pinnacles rise close to the river near Campbell Creek and also shortly above Baird on the east side of the river. The so-called Baird caves are located in these latter peaks.

A short way below the Bollibokka Club is a good sized creek flowing in from the west. This is Nawtawakit, and although the drainage is not extensive it carries a good volume of water. It is a rough, steep stream full of boulders and heavily shaded. In it I saw a number of fine rainbow, all appeared to be 10 inches or less but they were well colored. Small stream rainbow such as these were the ones Livingston Stone referred to as red-banded trout. I saw no minnows in Nawtawakit. The mouth of this creek is on Bollibokka Club property and is closed to public fishing.

A few miles below this, Nosoni Creek enters from the east. This is a very pretty stream and has a more gradual ascent and is not as rough as most others in this region. There are many gravelly stretches and a number of fine pools. It is well shaded though not excessively so. The temperature is relatively high; in early July it ranged around 65° with the air at 95° F. It probably reaches 70° occasionally. The rocks have a fine growth of green filamentous algae in which there is an abundance of aquatic nymphs and larvae. Beside this excellent forage are many minnow fry and small fingerlings. These form a part of the rainbow diet. In fact, I watched a yearling trout catching them. The rainbow are abundant in the creek and their growth is remarkably fast. I saw fingerlings, doubtlessly of the year, which were 2½ to 3 inches long. The yearlings were 4 to 6 and the two-year-olds were 8 to 10 inches. Several aged rainbow were seen which ranged from 12 to 16 inches. This situation both in respect to the fish themselves and their environment, is much the same as we find in Squaw Creek which enters the Pit above the McCloud. I saw no large minnows which might be feeding on the young trout and young minnows. The only losses in the trout would seem to be from cannibalism and from birds. I saw a female merganser and her young brood in the creek in July. The trout conditions are good; in fact, I believe they are better than in any other lower McCloud tributary. The temperature is high enough for good growth, yet not too high. I would consider 80° for any length of time too high, but 70° under natural conditions is good for rainbow. The insect food is, of course, abundant and the presence of young minnows is an added source of food not often encountered. In fact, Nosoni Creek is the only tributary in the McCloud system where I found minnows. There is probably little fishing in this stream, for, as in the case of the other tributaries on the east side, it is either necessary to have a boat or take a long walk.

The next creek of importance to enter the river below Nosoni is Campbell Creek, but it does not seem to be as productive as Nosoni. However, I visited it later in the year, October 24, and this frequently makes a great difference. The middle of the summer seems to be much better for stream observations than any other time. The colder the water the less active are the fish and the more difficult they are to see. The time of day when a stream is visited plays a considerable part in the apparent amount of fish life. In streams with considerable shade I find that visits from 10 a.m. to 1 p.m. are much more fruitful than visits made earlier or later. Part of this is due to light conditions and part to feeding activity. Temperature cannot be the prime factor because we generally find the temperature greatest between 4 and 5 p.m. There is no question but what several visits to a stream at dif-

ferent times of day and year are necessary to insure a fair survey of conditions.

Campbell Creek at the time of my visit was flowing about five cubic feet per second, which is moderately large for the McCloud tributaries. The temperature was 53° at noon. In general characteristics, this stream is typical of the others in the region, except perhaps Nosoni.

Fig. 106. Campbell Creek. Summer, 1938.

The bed is rough, very rocky and with relatively few large gravel riffles. There are a few good pools and an abundance of shade trees. I saw no fish in the lower section and must class it as relatively unproductive.

Below Campbell Creek and on the same (east) side is Greens Creek, formerly Crooks Creek, and the site of the U. S. Fish Commission's trout egg-collecting station. This creek was flowing about half as much as Campbell on the same date. In the lower section it looked very unproductive—it was rough, heavily shaded, with few pools and very few gravel areas. The temperature was 52° F. I saw one fish, which I caught. It was a seven-inch rainbow, almost black, but after death it faded enough to show a rosy band and rosy lower fins. It must be that very few spawners ascend streams such as this one or I would have been able to find some fingerlings.

Caluchi Creek enters the river from the west, almost opposite Greens Creek. It is about the same size as Greens, from 3 to 12 feet wide and 6 inches to 2 feeet deep. It is unusually free from sheltering trees, due probably to the fact that it is grazed over more heavily. There are more good gravel and sandy stretches than in Greens Creek though at the same time there are some low falls and many riffles.

It appears to be one of the better streams for spawning. The temperature on December 6, 1938, was 53°. On this date I found a pair of king salmon in the creek which had just spawned. The male had just died and the female was quite active. On February 2, 1939, I went back hoping to find rainbow spawning. However, I found no fish at all, and believe that it must have been too early for them. The two salmon seen here were the only ones I saw in any of the tributaries. I saw one in the river nearby and a dead one near Rinkel's in November.

There are a few more small creeks between this point and the Pit, but they are very nearly dry in the summer and it is hardly worth considering them.

At the junction of the McCloud and the Pit under the old Bully Hill railroad bridge, I saw about 30 salmon fingerlings, 1¼ to 1½ inches long, feeding near shore. They were undoubtedly on their way to sea at the time, February 1, 1939.

FIG. 107. Looking toward mouth of Greens Creek from the west side of the river. Fall, 1938.

Future of the McCloud River

In discussing the future of the McCloud we have three principal questions to consider. First, will approximately 70 per cent of the river below Lower Falls remain in private hands and be closed to public fishing? Second, can the Mud Creek flow be arrested? Third, what effect will the future Shasta Reservoir have on the river?

As we have seen, there are three private interests involved on the river. William Randolph Hearst owns at present about 12¼ miles of the river from Lower Falls to Ah-di-nah. The excellent fishing waters held by the McCloud River Club on the river, on Squaw Valley, Claiborne and adjacent creeks will probably be retained as private property for some time to come. The section of the river owned by the Bollibokka

FIG. 108. Looking up Pit River to mouth of the McCloud (under the old railroad bridge, left center). Most of the area shown will be beneath the waters of the new Shasta Reservoir.

Club may be increased in value by the future reservoir which will come close to its lower limits. In all probability this section will also remain in private hands for some time to come.

Whether the Mud Creek flow will ever be rendered harmless depends largely upon our future weather conditions. It was the unprecedented warm, dry cycle which finally destroyed most of the Konwakiton Glacier in 1924 and allowed the melting snow to wash down the underlying glacial silt and sand. If another cold, wet cycle should occur we can expect to have relatively little trouble from this source. What little flow does come down could probably be cared for by the government's diversion system near the mouth of the gorge. If, on the other hand, the weather continues warm and dry we can expect an annual mud flow and an unsightly, unproductive river.

The future Shasta Reservoir will come up the McCloud River at least to the 1000-foot contour. This means a narrow arm of lake water up as far as the present end of the road, or approximately 13 miles from the mouth of the river. At no point, even including the extensions up Hirz and Campbell creeks, will the arm of the lake be over two miles wide—most of it will be from a quarter to an eighth of a mile in width. The canyon walls are rather abrupt but there will be many excellent locations for summer cabins and the amount of fishing will be increased many times its present intensity.

We can prophesy the kinds of fish to be found in the new reservoir with considerable accuracy, because on the Pit River, 43 miles by airline northeast of the mouth of the McCloud, lies Lake Britton, an excellent large-mouthed bass lake. There will be many fishermen who will want to see the new lake kept for trout and if this lake were suitable for trout and if it could be kept for them alone, there is little doubt but what it would be a trout lake. However, the altitude of this lake being approximately 1000 feet above sea level and in a section of the State which has long periods each summer with the air temperature around 100° F., and with very little really cold weather even in winter, it is to be expected that the water will be more nearly suited to black bass. In Lake Britton there is a small arm which extends up Burney Creek. The bass are particularly abundant in this arm despite the fact that the temperature of Burney Creek water ranges between 45° and 50° F. and the volume of this creek is large. As we have seen, the temperature of the water in the McCloud River is between 42° and 62° so we cannot, therefore, expect that arm or any arm of the lake to be any better suited for trout or more poorly suited for bass than the Burney Creek arm of Lake Britton.

If in no other way, the young bass in Lake Britton will drift over the dam and down the Pit in times of high water to the Shasta Reservoir. This does not necessarily mean that all the trout in the reservoir will be killed by the bass or by the high temperatures of the water. Undoubtedly, rainbow will remain in the deeper, cooler water and some will be taken by deep trolling or bait fishing. These trout will leave the reservoir at spawning time and run up the many fine trout streams which will feed the lake. Trout fishing in the streams will not be harmed by the new reservoir, but these tributaries will, however, become much more accessible by boat and the number of fish will decrease through overfishing.

It seems unlikely to the writer that any other game fish can be found for the reservoir which would be more suitable than black bass. However, a thorough study of the lake will be made after it has formed and if a superior game fish can be found, that one will be introduced.

Suggestions for the Improved Management of the McCloud River Drainage

1. None of the tributaries to the upper McCloud River seem to need planting at the present time, but should they be planted at any time in the future it is suggested that rainbow be used except in the headwaters of these tributaries where golden trout might be desirable from the standpoint of their unusual beauty.

2. It is suggested that the number of rainbow fingerlings planted in the upper McCloud River itself be proportionately increased and the number of Loch Leven and brook be decreased. The writer does not feel that the total number of fish planted in the upper section of the river need be increased. For a matter of fact, the upper river has received more than its share of fish in past years.

3. After the Shasta Reservoir has been formed in the lower section of the river, the McCloud tributaries to it may need planting, in which case it is suggested that rainbow be used exclusively.

Not only are the McCloud and its tributaries well suited to rainbow in every way, but there is some danger of Loch Leven spreading throughout the drainage and displacing the rainbow which are favored by the fly fishermen and which are bound to the river by historical association.

4. The writer feels that no closed streams are necessary or desirable in this drainage. This includes Tate Creek, which might well be opened to fishing. This stream is heavily populated at present with Loch Leven, which need little or no added protection, except through a shortened fishing season and a size limit, as is needed by all trout in California.

5. If the State was ever in a position to urge the maintenance of the Mud Creek diversion it would be to the benefit of the fishing interests, not only those who own property on the river, but the public who will fish below these private holdings. However, it is evident from the map which accompanies this report that there will be very little river left for public fishing after the reservoir is filled. The reservoir itself will become silted more rapidly through the work of Mud Creek and for this reason it would seem that the Federal Government might be especially interested in diverting the flow.

REFERENCES

BORNE, MAX VON DEM

1885. Distribution of American fish and fish eggs by the German fishery association. U. S. Fish commission. Bulletin, 1885, vol. 5, pp. 261-264.

CAMPBELL, J. B.

1882. Notes on McCloud River, California, and some of its fishes, based upon a letter of J. B. Campbell, of the United States fish commission. *Ibid.*, 1881, vol. 1, pp. 44-46.

CLARK, G. H.

1929. Sacramento-San Joaquin salmon (*Oncorhynchus tschawytscha*) fishery of California. California. Division of fish and game. Fish bulletin, no. 17, 73 pp.

CLARKE, H. R.

1885. Propagation of trout by the Southside club. U. S. Fish commission. Bulletin, 1885, vol. 5, p. 436.

GREEN, SETH

1882. Rearing of California mountain trout (*Salmo irideus*). *Ibid.*, 1881, vol. 1, p. 23.

JORDAN, DAVID STARR

1894.1. Descriptions of new varieties of trout. California. Board of fish commissioners. Biennial report, 1893-94, pp. 142-143.

1894.2. Salmon and trout of the Pacific coast. *Ibid.*, pp. 128-129.

McDONALD, M.

1887. Report of operations at the trout-breeding station at Wytheville, Va., from its occupation in January, 1882, to the close of 1884. U. S. Commission of fish and fisheries. Report, 1885, pp. 103-108.

1891. Report of Commissioner of fish and fisheries for 1887. *Ibid.*, 1887, pp. xviii-xix.

MAYNARD, H. J.

1889. Rainbow trout in southwestern Missouri. U. S. Fish commission. Bulletin, 1887, vol. 7, pp. 55-56.

METCALF, MARTIN

1883. Success in propagating California mountain trout from eggs brought to Michigan by the United States fish commission. *Ibid.*, 1883, vol. 3, pp. 471-472.

SMILEY, CHARLES W.

1884. Brief notes upon fish and fisheries. *Ibid.*, 1884, vol. 4, p. 360.

STONE, LIVINGSTON

1874. Report of operations during 1872 at the United States salmon-hatching establishment on the M'Cloud River, and on the California Salmonidae generally; with a list of specimens collected. U. S. Commission of fish and fisheries. Report, 1872-73, pp. 168-215.

1882. Report of operations at the United States trout ponds, McCloud River, California, during the season of 1879. *Ibid.*, 1879, pp. 716-717.

1885. Report of operations at the United States trout-breeding station on the McCloud River, California, during the year 1883. *Ibid.*, 1883, pp. 1003-1005.

1889. Report of operations at the U. S. salmon and trout stations on the M'Cloud River, California, for the years 1885-87. *Ibid.*, 1886, pp. 738-740.

A BRIEF HISTORY AND IDENTIFICATION OF THE THREE SPECIES OF BLACK BASS NOW OCCURRING IN CALIFORNIA[1]

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With the introduction of the spotted or Kentucky black bass into California, three species of black bass can now be caught by California sportsmen. Because of the increasing popularity of these fish and the interest shown in them, it is hoped that the following brief report will be helpful to bass fishermen or others interested.

The history of the large-mouthed and the small-mouthed varieties in California is quite indefinite. Seemingly, these two species were frequently grouped together in planting records or reports and called black bass. However, records would indicate that the small-mouthed bass was the first species to be introduced and was probably brought to California in 1874 by Livingston Stone. Shortly afterward the large-mouthed bass was introduced and both of these fishes were first planted in Napa and Alameda creeks in central California. The introduction of these fish met with considerable success, particularly the large-mouthed, and their distribution became widespread in the State. In 1933, through the assistance of Mr. T. H. Langlois, Chief of the Bureau of Fish Propagation of Ohio, a number of young spotted bass were brought into the State by airplane. These fish have since been held in the bass hatchery. Now adult fish, their young have been planted in the San Joaquin, Tuolumne, Cosumnes and Kern rivers.

The propagation of small-mouthed bass was started in 1933 when the Division of Fish and Game constructed an experimental hatchery on the San Joaquin River at the town of Friant. Upon ascertaining that these fish could be raised successfully, a permanent 40-acre plant was built near Elk Grove, Sacramento County. With fish raised at this hatchery, the Bureau of Fish Conservation hopes to establish and maintain small-mouthed and spotted bass in suitable waters throughout the State.

The large-mouthed bass frequently is caught in the same waters as the small-mouthed. As a rule, however, it is a fish of the warm, standing and sluggish waters of the Central Valleys river system and of warm water lakes throughout the State. The sloughs and tule ponds of the lower regions are its favorite haunts. Because of this preference, its range is much greater in California than that of the small-mouthed, which, in contrast, prefers cooler, clearer and faster water. In many respects the spotted bass is intermediate between the large-mouthed and the small-mouthed. It is associated with deep water or streams that are deeply shaded. The natural range of this species indicates that warm water is essential.

Only a brief outline of the characteristics of the species of black bass will be given, in which contrasting characters will be stressed.

[1] Submitted for publication, June, 1939. Photographs by Chester Woodhull.

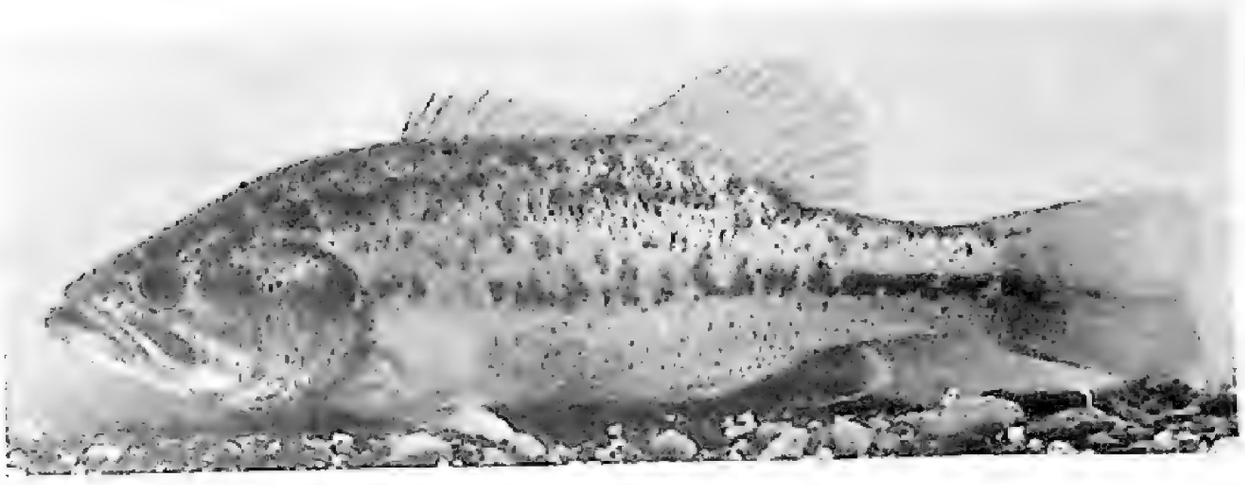

FIG. 109. The large-mouthed black bass, *Micropterus salmoides.*

The principal distinguishing characteristics of the large-mouthed black bass are as follows: Color pattern consisting of a more or less prominent, dark, regular, longitudinal line or stripe. There is a distinct notch between the spines and the rays of the dorsal fin. The maxillary bone extends beyond the posterior margin of the eye in the adult. There are ten rows of scales on the cheek. (See Fig. 111.)

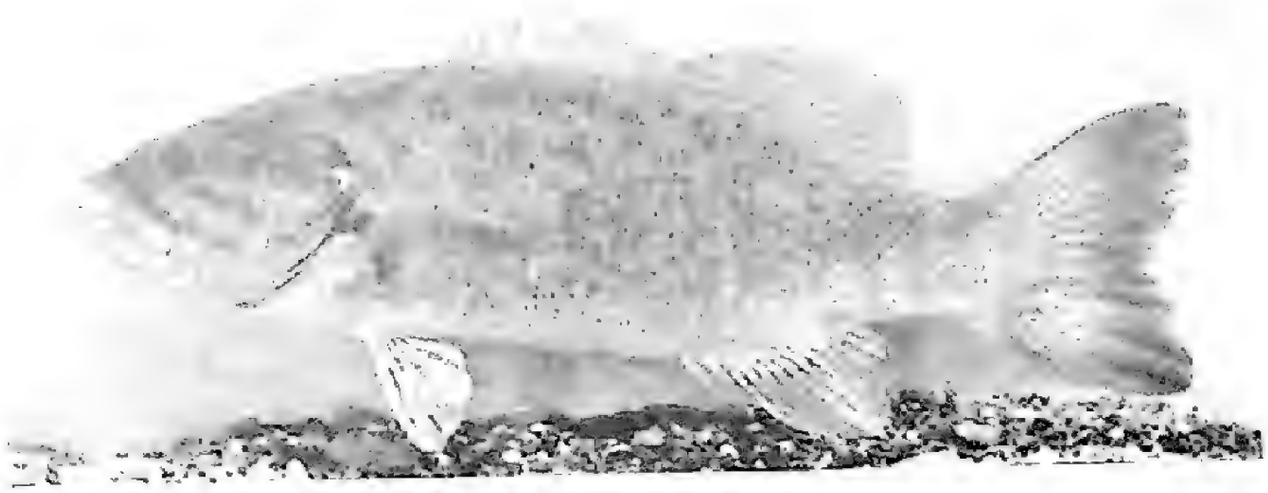

FIG. 110. The small-mouthed black bass, *Micropterus dolomieu.*

In the small-mouthed black bass, the color pattern is golden green to bronze with vertical bars sometimes becoming obscured with age. The vertical bars are particularly noticeable when the fish is excited or during the spawning season. Dark band on the caudal fin of the young is pronounced. There is not a distinct notch between the spines and the rays of the dorsal . The maxillary bone does not extend beyond the eye in the adult. Frequently, the eye is reddish-orange. There are 17 rows of scales on the cheek.

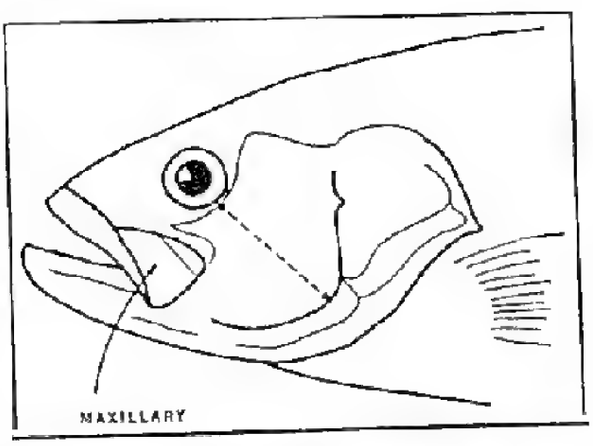

FIG. 111. The head of a small-mouthed black bass. Note the length of the maxillary in relation to the eye. The dotted line shows direction in which rows of scales are counted.

In color the spotted bass is like the large-mouthed, but it is characterized by prominent black spots along the lower sides. Back often golden or bronze. Shape more like the small-mouthed. Dark spot at the base of the caudal remains through adult stage. Notch between

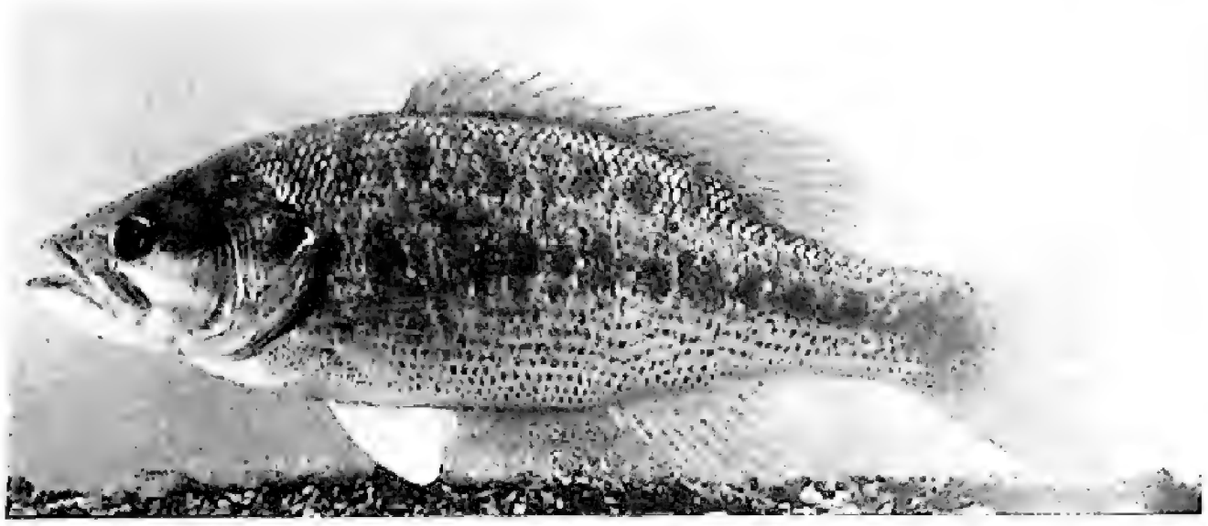

FIG. 112. The spotted black bass, *Micropterus pseudaplites*, also known as Kentucky bass.

spines and rays of dorsal not as deep as in the large-mouthed black bass; instead, the spines and rays are well connected. There are 15 (occasionally 14) rows of scales on the cheek. The maxillary extends back to the middle of the eye (usually not so far as in figure 112).

REFERENCES

EVERMANN, BARTON WARREN, and CLARK, HOWARD WALTON.

1931. A distributional list of the species of freshwater fishes known to occur in California. California. Division of Fish and Game. Fish Bulletin, no. 35, 67 pp.

FORBES, S. A., and RICHARDSON, R. E.

1920. The fishes of Illinois; 2nd ed. Illinois State Laboratory of Natural History. Natural History Survey, vol. 3, 357 pp., pls.

HUBBS, CARL L., and BAILEY, REEVE M.

1938. The small-mouthed black bass. Cranbrook Institute of Science. Bulletin, no. 10, 89 pp., 9 pls.

WALFORD, LIONEL A.

1931. Handbook of common commercial and game fishes of California. California. Division of Fish and Game. Fish Bulletin, no. 28, 181 pp., 137 figs.

CALIFORNIA FRESH-WATER FISHES AND THEIR POSSIBLE USE FOR AQUARIUM PURPOSES [1]

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INTRODUCTION

"It seems to be human nature, especially in America, to assume that the best things come from distant lands—the more distant, the better," says William T. Innes in "The Complete Aquarium Book." "In this search for the rare and interesting we are apt to overlook excellent material close at hand. We have many handsome native fishes admirably adapted to aquarium purposes. They are easily managed, tenacious of life, varied in habits and easily tamed. Those who have made collections of our own fishes have found much pleasure in this form of aquarium hobby.

"There are pleasures connected with the stocking of a wild-fish aquarium which are unknown to those interested only in goldfishes. The actual contact with Nature, the study of the fishes in their native habitat, the ever-present possibility of finding something new, the companionship and health afforded on outings are some of the pleasant assets of the collector."

There is much truth in what Innes says. We must consider, however, that he speaks as an easterner. The eastern and middlewestern parts of the United States are infinitely richer in their native fresh-water fish faunas, both as to numbers and kinds of fishes, than is California. In the United States as a whole (according to the late David Starr Jordan in 1928) there are about 681 species of fresh-water fishes. In California there are only 74 native species, including anadromous forms, that is, those fishes that run from salt to fresh water for spawning purposes, and those species able to withstand salt or brackish water. We have no bowfins, darters, or pirate perches. We lack the red-bellied dace, considered by many one of the most beautiful of native aquarium fishes. And we lack the variety of sunfishes that occurs in the East and Middle West. The entire Eel River system, for example, the third largest river system in our State, stretching from near Humboldt Bay in the north to Willits in the south and inland to the divide with the Sacramento drainage, possesses only one true fresh-water fish, a sucker. Furthermore, the number of genera is not large, and any one stream or lake available in the collector's immediate locality is apt to have but a few species present. Nevertheless, there is a fair number of species which we shall discuss that can be obtained for aquarium use.

[1] Submitted for publication July, 1939. Figures 116, 118 and 119 have been taken from Jordan and Evermann, "Fishes of North and Middle America," and are published by permission of the U. S. National Museum. Figure 114 is from Donald H. Fry, Jr., "Life history of *Hesperoleucus venustus* Snyder," California Fish and Game, vol. 22, pp. 65-98, 1936.

The close relationships of many of these fishes, particularly the Cyprinidae, or minnows, make their identification rather difficult. No one book or paper includes them all, and obtaining the scattered literature is a difficult task. It is also difficult to use common names. In the case of the birds there have been so many students, both professional and amateur, that even the subspecies have definite, accepted common names. Our game and commercial fishes, too, have been given common names by the vast army of anglers and by the commercial fishermen, but this is not true of the non-game and non-commercial fishes, the ones most suitable for aquarium purposes. "Shiners" and "minnows" are terms that have been applied to many different fishes. At the same time, *Ptychocheilus grandis*, the Sacramento pike (which might better be named Sacramento squawfish), has also been called just plain pike, whitefish, lakefish, hardhead, steelhead, and hardmouth. To add to the confusion, even the scientific names of our California fishes have been a constant matter of dispute.

All of this may seem to make the situation somewhat discouraging, but we believe that we should accept it as a challenge to work with these fishes from both the taxonomic and life history standpoints.

Now, let us take a look at the native fishes that occupied the streams of California when it was first settled by the Spaniards in 1769. From the following list we see that 11 families, 32 genera, and 74 species of anadromous and true fresh-water fishes are represented.

Native Fishes—Families and Genera

(1) Petromyzonidae (lampreys), 2 genera (*Entosphenus, Lampetra*), 2 species.

(2) Acipenseridae (sturgeons), 1 genus (*Acipenser*), 2 species.

(3) Salmonidae (salmon, trout, whitefish), 4 genera (*Oncorhynchus, Salmo, Salvelinus, Prosopium*), 20 species.

(4) Catostomidae (suckers and buffalo fishes), 4 genera (*Ololepidomyzon, Pantosteus, Catostomus, Xyrauchen*), 11 species.

(5) Cyprinidae (daces and minnows), 15 genera (*Orthodon, Mylopharodon, Lavinia, Ptychocheilus, Gila, Pogonichthys, Richardsonius, Tigoma, Siboma, Hesperoleucus, Mylocheilus, Siphateles, Leucidius, Oregonichthys, Apocope*), 27 species.

(6) Cyprinodontidae (killifishes), 1 genus (*Cyprinodon*), 3 species.

(7) Gasterosteidae (sticklebacks), 1 genus (*Gasterosteus*), 1 species.

(8) Centrarchidae (black basses, sunfishes and pumpkin seeds), 1 genus (*Archoplites*), 1 species.

(9) Cottidae (scaleless sculpins), 1 genus (*Cottus*), 5 species.

(10) Embiotocidae (surffishes, viviparous perches), 1 genus (*Hysterocarpus*), 1 species.

(11) Gobiidae (gobies), 1 genus (*Eucyclogobius*), 1 species.

Introduced Fishes

During the first years following its organization in 1870, the most consequential work done by the California Fish and Game Commission was the introduction of new fishes into the State, from the eastern United States and other parts of the world. By 1895, practically all of the most important introductions had been made. The most successful introductions, together with the dates of introduction, are the following: Potomac shad, *Alosa sapidissima* (1871); carp, *Cyprinus carpio* (1872); eastern brook trout, *Salvelinus fontinalis* (1872); catfishes, *Ameiurus nebulosus* and *A. catus* (1874); black basses, *Micropterus salmoides* and *M. dolomieu* (1874); striped bass, *Roccus lineatus* (1879); crappies, *pomoxis sparoides* and *P. annularis* (1891); Great Lakes trout, *Cristivomer namaycush* (1894); brown trout, *Salmo trutta* (1894 and 1895); bluegill, *Lepomis macrochirus* (1895); green sunfish, *Lepomis cyanellus* (1895); mosquito fish, *Gambusia affinis affinis* (1922).

FISHES USEFUL FOR AQUARIUM PURPOSES

Even with these introduced forms the list of fishes to be found in the streams and lakes of California does not reach an imposing length, especially if we exclude the anadromous forms, such as the sea lampreys, sturgeons, salmon, trout, shad, and striped bass, and those species able to withstand salt or brackish water, such as the sculpins, sticklebacks, and gobies.[2] However, let us examine these groups in greater detail and see just what values they have for aquarium use.

(1) Suckers and Buffalo Fishes—Family Catostomidae

The best known member of this family, *Catostomus occidentalis*, the Sacramento coarse-scaled sucker (see Fig. 113), is also the most widely distributed. It is found throughout the Sacramento-San Joa-

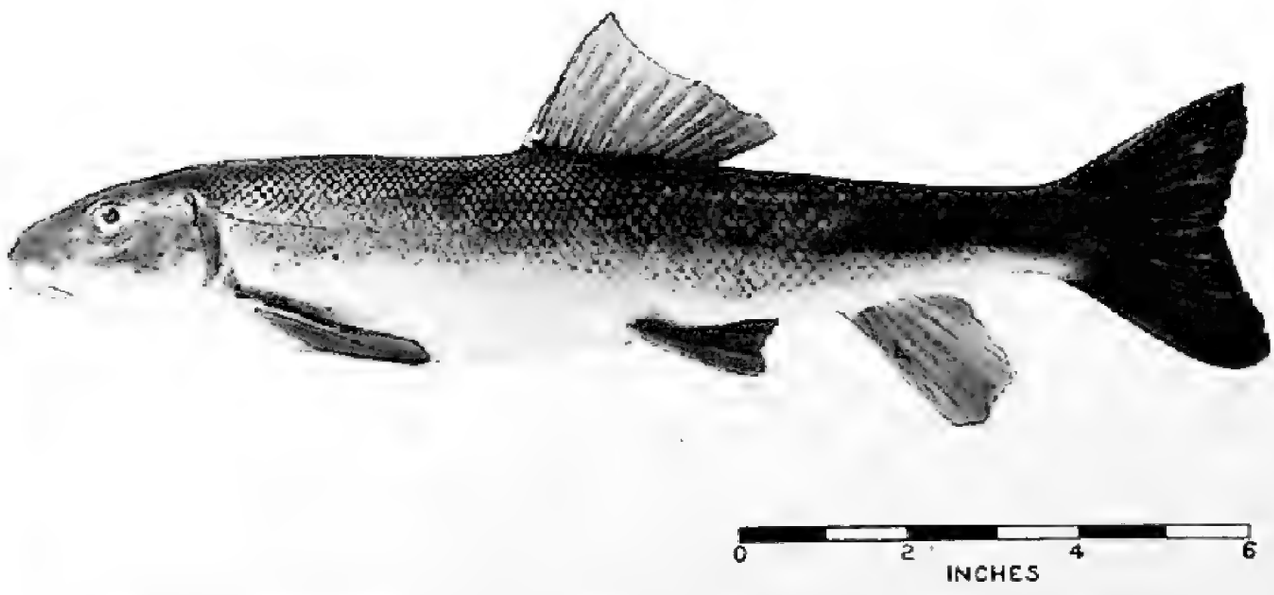

FIG. 113. Sacramento Coarse-scaled Sucker, *Catostomus occidentalis*; family, Catostomidae.

[2] Trout are sometimes kept satisfactorily in cool garden pools. However, an ample supply of cold, well-aerated water (preferably with a definite current) is required for good results. The proper facilities for keeping them usually are not available to the amateur aquarist.

quin system, in the Russian River, and in several of the smaller streams entering San Francisco Bay. Like other suckers, it has fleshy lips and toothless jaws fitted for bottom feeding. Its yellowish-brown coloration is not striking, but during the breeding season the males develop brighter hues on the body and fins.

Another species of sucker, *Catostomus tahoensis*, found in the Truckee River and Lake Tahoe, develops a beautiful "rainbow" along the sides of its body in spring and early summer. Occasionally inexperienced anglers carry it home, sincere in the belief that they have creeled a rainbow trout.

The sand-bar sucker (*C. arenarius*) of the Truckee River and neighboring streams, in common with some of the other suckers found in the State, also develops a bright red lateral stripe during the breeding season.

Only the smaller individuals should be kept in home aquaria, where they will subsist on goldfish food. Several species of suckers can stand quite warm temperatures.

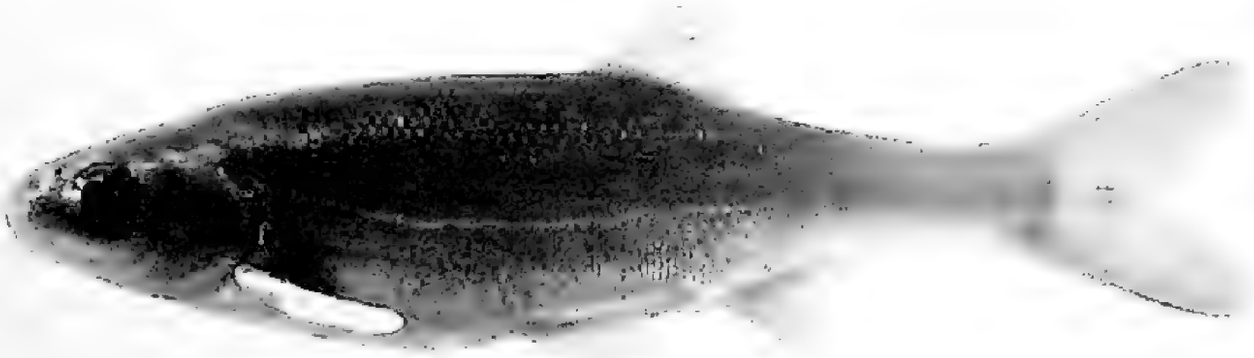

FIG. 114. Venus Roach, *Hesperoleucus venustus;* family, Cyprinidae.

(2) Daces and Minnows—Family Cyprinidae

The members of this family are well known to aquarists. Common exotic cyprinids are: goldfish, barbs, Danios and Rasboras. As a general rule they are plant feeders, but quite often eat dried or live animal foods as well. Many are quite active in aquaria.

In California streams they form the dominant family, containing over one-third of all the native fresh-water species. Almost every river system has some representatives. Often a particular species is limited to a particular stream, and this has made possible some excellent distributional studies.

Western species belie the diminutive term "minnies," for some of them, such as *Orthodon, Mylopharodon and Ptychocheilus,* attain a length of a foot or more. *Ptychocheilus lucius* of the Colorado River has the distinction of being the largest minnow in the United States—one individual being credited with a length of five feet and a weight of eighty pounds.

Its commoner relative, *Ptychocheilus grandis*, the Sacramento pike (Sacramento squawfish) of the Sacramento-San Joaquin drainage and coastal streams, may occasionally reach a length of four feet. This rakishly lean fish is seemingly of dull coloration when viewed from above. Freshly caught individuals, however, display forest-green sides

twinkling with golden lights, orange fins and silvery white belly. Like several of the other minnows it will sometimes rise to a fly and hence is well known to anglers. It is an active and greedy aquarium fish, often preferring live food, such as Gambusias.

Other common cyprinids are: the blackfish (*Orthodon microlepidotus*), hardhead (*Mylopharodon conocephalus*), hitch (*Lavinia exilicauda*), several species of roach (*Hesperoleucus*) (see Fig. 114), and split-tail (*Pogonichthys macrolepidotus*). All of these have been kept in aquaria or garden pools.

Like the suckers, most California minnows are silvery or dusky, but may attain a spawning cloak of varied hues. Perhaps the most beautiful native minnow is the little red-striped shiner, *Richardsonius egregius*, found in Lake Tahoe and its tributary streams. Starting from the eye, a golden stripe extends along the side, and just below this is a brick red stripe. In the early summer it spawns—attaching its pale gray adhesive egg masses to the undersides of rocks either in the lake or in its tributary streams. Spawning has been seen to occur at a water temperature of 67° F. in the lake.

Three introduced forms which live well in aquaria are: the carp (*Cyprinus carpio*), golden shiner (*Notemigonus crysoleucas*), and tench (*Tinca tinca*). Carp are well established in many lakes and streams of California.[3]

Notemigonus was last reported in lakes and small streams near San Diego. It has been kept in captivity for seven years, according to Mellen and Lanier (1936). Any finely ground goldfish food is suitable provender for it.

Not yet an inhabitant of our natural waters, but present in ponds near Half Moon Bay, is the tench, a fish credited by Izaak Walton as being the personal physician of the English pike. At one time it was reputed to be capable of curing the diseases of other fish which rubbed against it. It was even said that a man could be cured of fever, headache, or toothache if a tench were placed against his hands or feet. The tench needs no fanciful tales, however, to make it an interesting fish. Its tenacity of life in the presence of little oxygen is in itself remarkable.

Most species of native cyprinids can withstand fairly high temperatures.

(3) Killifishes—Family Cyprinodontidae

This is another family familiar to aquarists who have kept *Gambusia*, *Panchax* or *Rivulus*.

Our best known native is the chubby desert top minnow, *Cyprinodon macularius* (see Fig. 115). Dwelling in springs and water holes in Southern California, about the Salton Sea and other places, it is able to withstand severe conditions of salinity and high temperatures. Just how high a temperature this species will tolerate over a period of time we do not know, but Robert J. Lanier, Assistant Superintendent of Steinhart Aquarium, says that it will spawn and does well in a tem-

[3] That commonest of aquarium fishes, the goldfish, *Carassius auratus*, was originally introduced into the State for aquarium purposes, but has now become abundant as a wild fish in many lakes, where quite often it reverts to its ancestral color of gray or green. It is sometimes caught by persons to take home for their ponds.

perature of 80° to 86° F. On one occasion the temperature accidentally went up to 110° F. Two of the fish died, but the remaining fifteen survived and lived for many months, apparently none the worse for this accidental experiment. The following day the temperature was slowly reduced to 86° F. and the survivors began feeding as though nothing had happened.

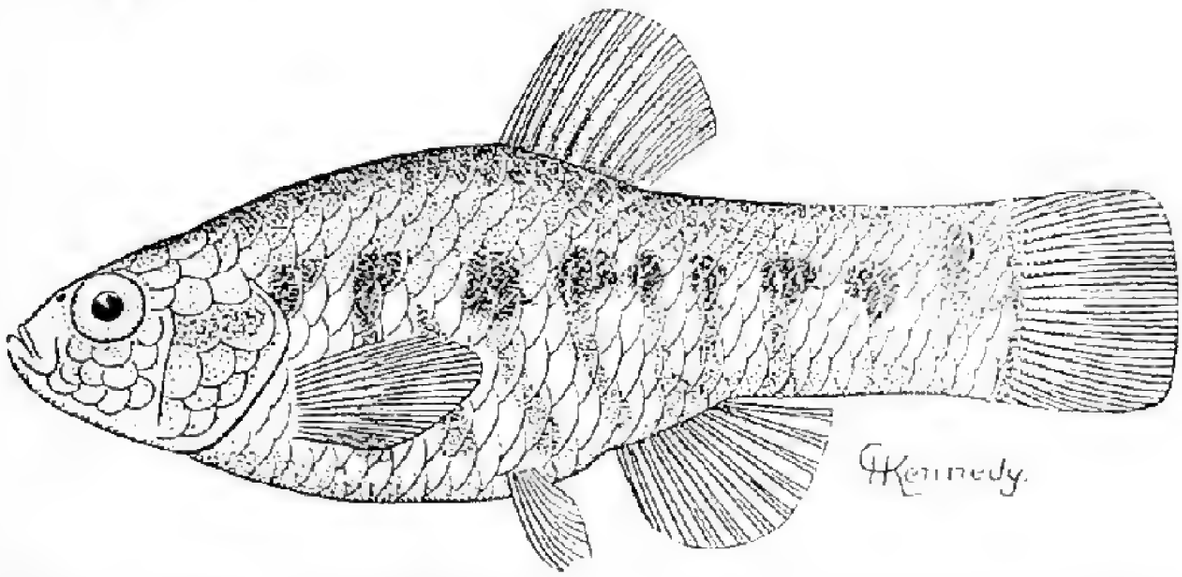

FIG. 115. Desert Top Minnow, *Cyprinodon macularius;* family, Cyprinodontidae.

Although it is seldom over one and three-quarters of an inch in length, the male is our most beautiful native aquarium fish, in the opinion of Alvin Seale, Superintendent of Steinhart Aquarium. During the breeding season its iridescent blue and red fins with their edging of greenish-blue make it exceptionally vivid.

It may be kept either in the garden pool or an inside aquarium, and will breed in captivity. The roots of floating plants such as *Lemna* will serve for the attachment of its eggs. It has been recommended that the adults be removed soon after spawning, as they will begin to fight.

Several other warm water cyprinodonts are recorded from the deserts of the southwestern United States, but little is known as to their suitability for aquaria. Moreover, collecting of them is not encouraged, as the number of individuals is not great.

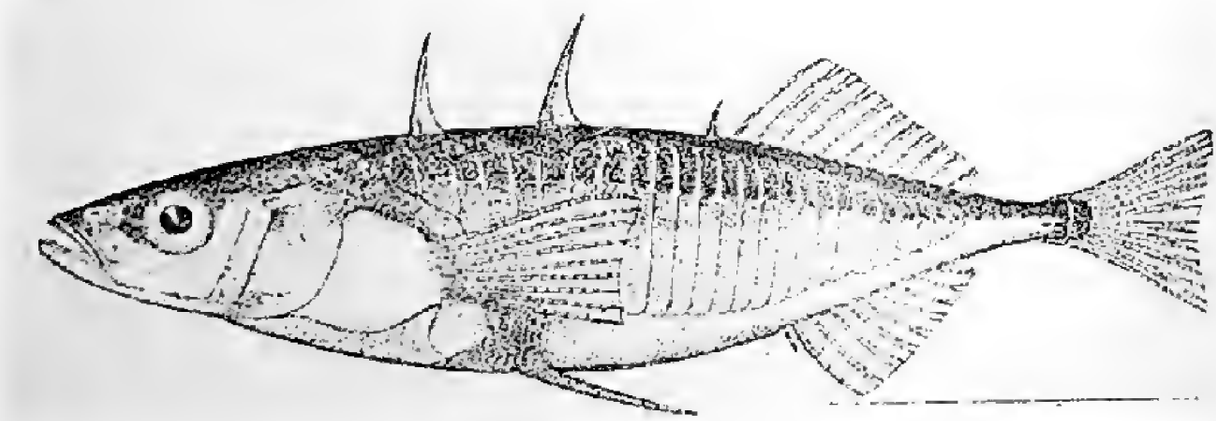

FIG. 116. Common Stickleback, *Gasterosteus aculeatus;* family, Gasterosteidae. Line indicates one inch.

(4) Sticklebacks—Family Gasterosteidae

So many accounts have been written of these interesting little nest-builders that we shall mention only that the one species, *Gasterosteus aculeatus* (see Fig. 116), is very common in California and makes a fascinating species for the small tank.

(5) Black Basses, Sunfishes and Pumpkin Seeds—Family Centrarchidae

California has been liberally endowed with native trouts and salmons but cannot compete with the eastern and mid-western states in its representation of the sunfishes. The Sacramento perch, *Archoplites interruptus* (see Fig. 117), is the only native sunfish west of the Rockies. Legally a game fish, it makes, however, a good aquarium fish, as neither controlled temperature nor careful feeding is important for its well-being. It has been kept in outside ponds and cold-water

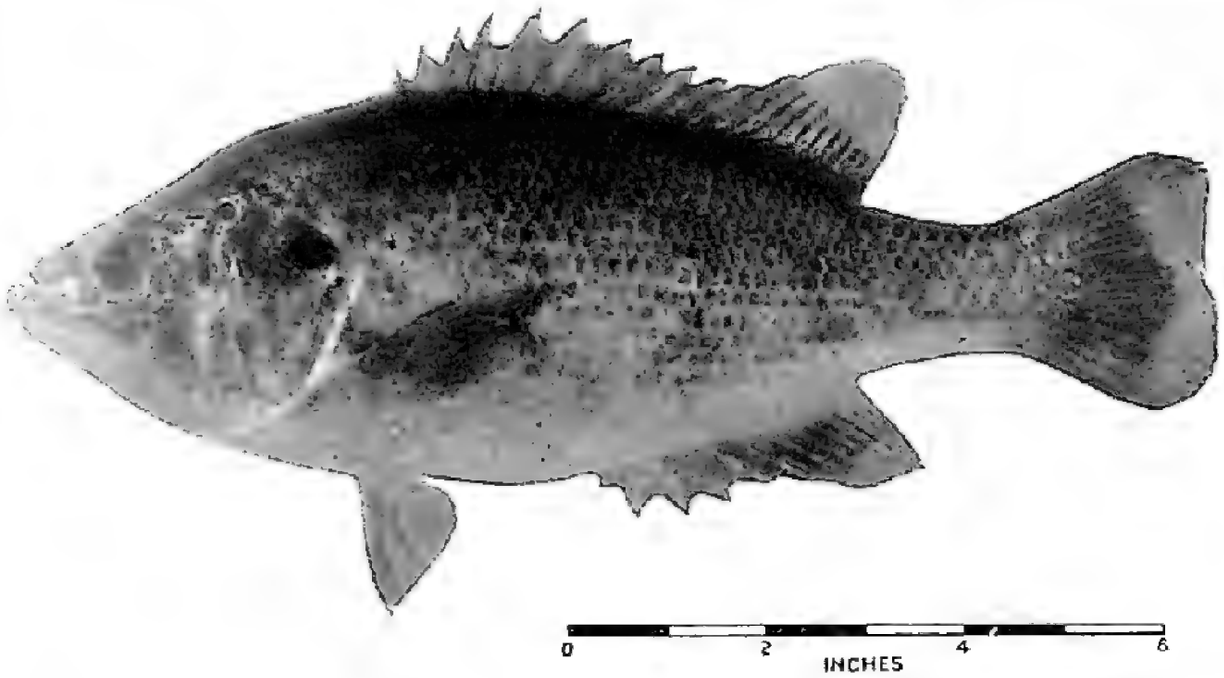

FIG. 117. Sacramento Perch, *Archoplites interruptus;* family, Centrarchidae.

aquaria and fed almost exclusively on *Gambusia*. It has been kept at the Steinhart Aquarium in San Francisco for six years.

Unfortunately, this solitary native centrarchid has declined in numbers. The cause of this decline is unknown. Some observers have roughly correlated it with the introduction of catfish, carp, and striped bass. It is known to be less aggressive than most sunfish in protecting its spawn (long strings of eggs draped over aquatic plants), and competitor fishes may have caused damage by destroying these egg-strings. Perch which eat catfish sometimes rupture their stomachs on the latter's pectoral spines. During the past few years *Archoplites* apparently has become more numerous in the San Joaquin River, however, and perhaps it will be able to reestablish itself in its former numbers.

The introduced centrarchids are more brightly colored or marked than is *Archoplites*. Crappies, bluegills, green sunfish, and black basses now constitute a considerable proportion of the populations of our

Central Valleys streams and warm water lakes. All are game fish, but young ones make excellent pond or aquarium fishes. Since they are a pugnacious tribe they should be kept by themselves. Live or raw foods are best. They are able to withstand high temperatures, are easy to transport, and, in addition to these practical advantages, have striking coloration and interesting habits.

(6) Scaleless Sculpins—Family Cottidae

Less "standardized" than the preceding fishes are the scaleless sculpins, also known as miller's thumbs, blobs, or bullheads. Most sculpins are marine, but five species, all of the genus *Cottus* (see Fig. 118),

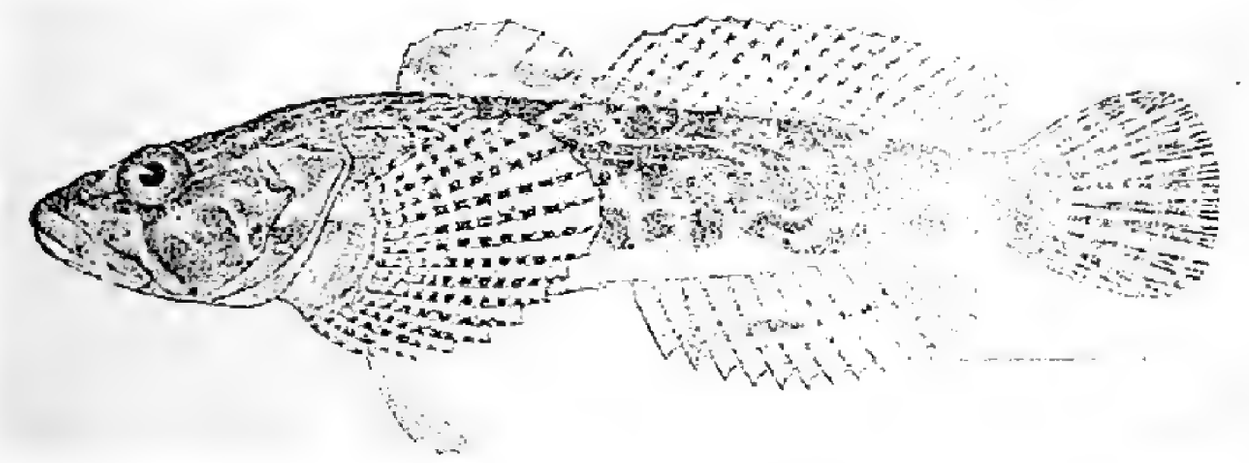

Fig. 118. Klamath Sculpin, *Cottus klamathensis;* family, Cottidae. Line indicates one inch.

are found in the streams and lakes of California. (The familiar marine cabezone of our rocky coast is a sculpin). Their broad heads, large pectoral fins, and preopercular spines make them interesting inhabitants of cold water tanks, where they tend to remain at the bottom or hide under stones. They are able to withstand poorly aerated water, so their transportation is simplified.

Both *Cottus asper* and *C. aleuticus* have been kept in outdoor pools. In nature they are quite voracious, feeding on other fishes and their own kind. Fish eggs and insect larvae also form a considerable portion of their diet.

Fresh-water sculpins deposit their eggs on stones, sticks and boards.

(7) Viviparous Perches—Family Embiotocidae

With regard to its method of reproduction, perhaps the most interesting fresh-water fish in our streams is *Hysterocarpus traski,* the fresh-water viviparous perch (see Fig. 119). This species has the distinction of being the first fresh-water fish described from California (by Gibbons in 1854). Its viviparous habit is a greater distinction, however, and it is the only member of the family which is not marine.

The other viviparous perches are common inhabitants of Pacific Coast beaches and are classed as food fish. All are deep-bodied fishes like the sunfishes, but have cycloid scales and a long anal fin.

As yet the life-history of *Hysterocarpus* has not been worked out, but it is undoubtedly similar to that of the marine forms. Since the mode of development is unique, a brief account of it in one of the salt-water forms (*Cymatogaster aggregatus*) may be of interest. In June, copulation (probably merely the approximation of the genital orifices) occurs and the sperm is transferred to the female. Fertilization, however, does not take place until the following December, and the young are not born until May. These young develop in ovarian sacs having no connection with the parent. When the first gill-slit opens, ovarian fluid passes through it into the digestive tract. Cilia pass this fluid along through the gut, where it is absorbed as food. Later the mouth opens and likewise takes in this nutritive fluid. Even excess spermatozoa are utilized as food by the developing young. Respiration is provided for by the absorption of oxygen in the ovarian fluid through the walls of the gut and by the vascular fins. When the young are born they are able to care for themselves. *Hysterocarpus* produces litters of from twelve to twenty young. Some of the marine forms may produce eighty offspring.

Most of the adult *Hysterocarpus* are about three and a half to four inches long. Their coloration is rather variable. Females are often green-bodied with darker transverse bars on the sides. The belly and throat are bright yellow. The duller males have dark brown backs

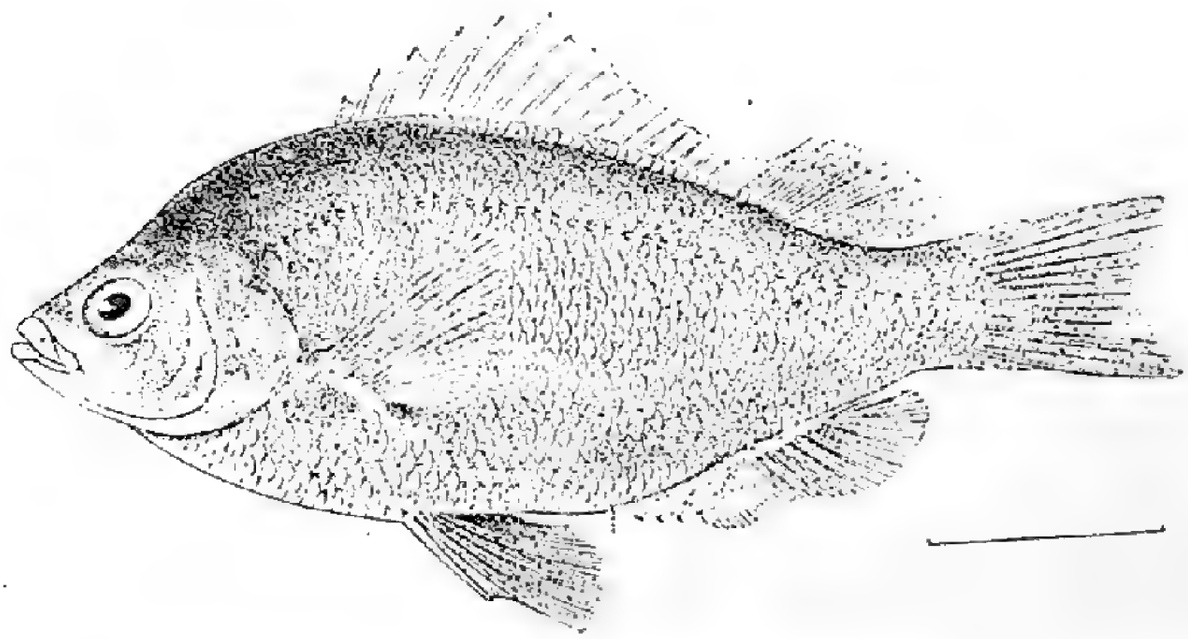

FIG. 119. Fresh-water Viviparous Perch, *Hysterocarpus traski*; family, Embiotocidae. Line indicates one inch.

with yellow or silvery sides. Some taken from the Salinas River are purplish.

They have been kept in aquaria at room temperature and in outside pools for considerable periods, and have been bred in the latter. Alkaline water is preferred.

(8) Gobies—Family Gobiidae

There are a number of marine representatives of this family living in the shore waters of the State, but Newberry's goby (*Eucyclogobius newberryi*) is the only fresh-water species. This little goby, reaching a length of only about two inches, is found in the lower courses of the coastal streams of central California. It is locally common in San Luis Obispo Creek and coastal streams of Santa Cruz County. The coloration is olivaceous, mottled with darker on body and fins; the caudal fin is faintly barred. Little is known of its adaptability to aquaria.

* * * * * * *

The introduced eastern catfishes, *Ameiurus catus* (fork-tail catfish) and *A. nebulosus* (square-tail catfish), are now resident in our streams and lakes. They are both hardy fishes and can be kept easily in aquaria with other fishes.

HINTS ON COLLECTING AND HOLDING

From this discussion of the various groups, we see that we have a number of interesting fishes that should live well in aquaria. Many are adapted to survive summer conditions of low water and high temperatures, so frequently encountered among California's streams, and have thus developed a hardiness which should enable them to exist well under artificial conditions. It must be borne in mind that although these fishes often lose their color on capture they soon regain it in aquaria.

An advantage that our native fishes possess over tropicals is that room temperature is satisfactory for most of them. This eliminates the bother of heaters and thermostats. The absence of the latter renders an aquarium more attractive, we believe.

Of course, if we are to use some of the native fishes that we have mentioned, we must use young, or at least not fully grown, individuals.

We have seen that many of our native fishes are generally rather drab in coloration, but some of them become quite attractive in form and color at the breeding season.

The keeping of native fishes offers one an excellent opportunity to study their habits and to try out new foods. There is also the challenge to the aquarist's skill in trying to breed these fishes, and one of the real privileges in this hobby or study is that of collecting the fish for one's self. Almost any stream or lake with the exception of some in the high mountains will usually yield some native fish, but of all the streams and river systems in this State, the Sacramento-San Joaquin is the richest in its fauna.

In making a collection it is well to take along some sort of simple pH (hydrogen-ion concentration) outfit, to indicate the degree of alkalinity or acidity of the waters in which the fish were collected.[4] It is rather generally believed that tropical fishes do best in slightly acid water, and for this reason many home aquaria are kept on the acid side.

[4] A simple method of pH determination is that by the Nitrazine paper method. The Squibb Company puts out Nitrazine paper in vials containing 100 strips, together with a color chart. These sell for a very moderate price. At present they are not entirely satisfactory because of the incomplete color chart, but we have written to the Squibb Company and they inform us that they are now attempting to work out color charts that will indicate all of the degrees of acidity or alkalinity.

However, many of the native California fresh-water fishes occur in alkaline waters. In such cases, the collected fishes will undoubtedly do much better if the pH of the aquarium is regulated so that it will approach that of the natural water. The commonest methods for regulating pH in aquaria are as follows: the addition of plaster of Paris will overcome acidity; acid sodium phosphate will overcome alkalinity.

Although this discussion has dealt with fresh-water fishes, we might keep in mind that some of the marine fishes, such as sculpins, blennies, *Gibbonsia* (Clinidae), and *Oxyjulis* can be kept in salt water aquaria. As a mater of fact, most salt-water non-pelagic fishes, as well as many invertebrates, do well in home aquaria if these are equipped with circulating water. Also, some brackish water and tidal fresh-water fishes will do well even if kept in a fresh-water aquarium. An example is *Fundulus parvipinnis*, of southern California, a relative of the well known aquarium fish *Heteroclitus* of eastern waters. The habits of our western form are not very well known, and it would be interesting to work these out. Many fresh-water clams, snails and insects also do well in home aquaria and add interest to them.

The subject of collecting fish for aquarium use has not often come up from a legal viewpoint, but some sections of the California Fish and Game Code are rather broad, and to avoid any difficulties it is advisable to apply to the Division of Fish and Game, Ferry Building, San Francisco, for a permit before collecting. Such a permit will probably be granted quite easily. It is well to keep in mind that there are certain restrictions in various districts regarding size of mesh or nets, etc., and also regarding taking of game fishes, accidentally or on purpose, and in collecting one should be acquainted with these restrictions in order to avoid any difficulties on encounter with a warden.

There are good reasons for these restrictions. Their importance, especially as regards non-game fishes, lies perhaps not so much in the collecting of the fishes as in their disposal afterwards. There is sometimes a tendency to get a fish from one place, and, after keeping it for a while, to tire of it, and rather than killing it, to dump it into the first convenient stream or lake. But this is the wrong thing to do. Section 561 of the Code provides that it is unlawful to place or plant any live fish or aquatic plant, whether from without or within the State, into State waters without permission. The main reason for this regulation is that we wish to guard against the introduction of fishes into waters in which they were not previously present. Accidentally or on purpose, many such undesirable introductions have already been made in the United States. The carp was long ago introduced into many American waters and now Wisconsin, New York, and other States spend large amounts of money annually in attempts to eradicate it. Disastrous effects also have been suffered through the introduction of non-native species of animals other than fishes, and of plants. Examples are the English sparrow and starling in the United States, rabbits in Australia, and numerous insect pests and weeds throughout the world.

The introduced forms are not always undesirable in themselves, but often disturb already existing relationships. For example, bass should not be introduced into trout waters, for they are likely to compete with the trout for food and to prey upon them. Many good trout

waters have been ruined by accidental or thoughtless bass planting. In most cases it is better to keep our streams with their natural fauna and balanced relationships than to bring in questionable exotics.

REFERENCES

The authors know of only two popular books which discuss our native western fishes.

MELLEN, IDA M., and LANIER, ROBERT J.

1936. 1001 Questions Answered About Your Aquarium. New York, Dodd, Mead & Co.
The only aquarium book treating of California fishes.

SCHRENKEISEN, RAY.

1938. Field Book of Fresh-Water Fishes of North America North of Mexico. New York, G. P. Putnam's Sons. 312 pp., illus.
It contains popular descriptions and line drawings of the common species of our fresh-water fishes. Unfortunately, its inaccuracies are all too many.

Those interested in a rather extensive bibliography of the scientific papers on California natives should refer to "A Distributional List of the Species of Freshwater Fishes Known to Occur in California," by Barton Warren Evermann and Howard Walton Clark (California Division of Fish and Game, Fish Bulletin no. 35, 1931, 67 pp.).

A number of the fishes to which reference has been made may be seen in the Steinhart Aquarium in San Francisco. The following species are or have been displayed there:

Catostomus occidentalis (Sacramento Coarse-scaled Sucker)
Orthodon microlepidotus (Blackfish)
Lavinia exilicauda (Hitch)
Ptychocheilus grandis (Sacramento Pike)
Pogonichthys macrolepidotus (Split-tail)
Hesperoleucus symmetricus (California Roach)
Hesperoleucus venustus (Venus Roach)
Cyprinus carpio (Carp)
Cyprinodon macularius (Desert Top Minnow)
Gambusia affinis affinis (Mosquito Fish)
Archoplites interruptus (Sacramento Perch)
Lepomis macrochirus (Bluegill)
Pomoxis sparoides (Black Crappie)
Micropterus salmoides (Large-mouthed Black Bass)
Cottus gulosus (Riffle Sculpin)
Gasterosteus aculeatus (Common Stickleback)
Hysterocarpus traski (Fresh-water Viviparous Perch)
Ameiurus nebulosus (Square-tail Catfish)
Ameiurus catus (Fork-tail Catfish)

IS THE PURSE SEINE AN ENGINE OF DESTRUCTION?[1]

By W. L. Scofield
State Fisheries Laboratory
California Division of Fish and Game

When a new and effective machine is introduced into an industry, it usually meets with opposition and hatred, and frequently its very efficiency is condemned as destructive to the best interests of the industry. This machine age furnishes many examples, for instance, the condemnation of horseless carriages for their horrible smell, scaring horses, dangerous speed, discomfort from dust, and as impractical because of constantly breaking down, yet finally we were compelled to accept automobiles because of their efficiency. New kinds of fishing gear have had to meet similar opposition, but in these cases those whose employment was threatened by the new gear usually argued that the new invention was destructive to the fish supply, implying that the supply would be safeguarded if old methods of fishing could be continued.

The purse seine is a simple wall of webbing laid out in a circle around a school of fish and closed at the bottom by pulling a "purse line," which has been threaded through rings at the bottom of the net so that the school of fish is impounded in the purse of webbing. The net is then pulled into the boat and the catch is bailed aboard the vessel. The standard size of these nets has been 200 fathoms around the cork line, but during the last few years in California, purse seines have been enlarged to 250 fathoms and in some cases the largest nets have measured over 300 fathoms. They are cast only when a school is sighted so that the catch as a rule is made up of but one species of fish. It is not often that quantities of any other kinds of fishes are mixed with the school which has been encircled. With the possible exception of fish traps which are illegal in this State, the purse seine is about the most successful device for making large catches in open and deep water.

In America the purse seine was first used in the Atlantic Coast menhaden fishery in 1826, where it met with opposition, and later it was objected to when introduced into California. It is still being attacked not only by small boat operators who fear its competition but also by sport fishermen as injurious to our stock of ocean fishes. There has been in California during the last twenty-five years an almost continuous war between purse seine operators and other fishermen with both sides resorting to surprise attacks, tricky legislation, misrepresentation and undesirable practices common to warfare. In the case of the purse seine there is little argument as to its efficiency as an imple-

[1] Submitted for publication, September 10, 1939.

ment for catching fish; its effectiveness is granted but many people object to it on this account. This raises the question of whether this net in itself is destructive because it is efficient, or is the unregulated operation of such a net the seat of the trouble? Is the villain in this play the net or the fisherman? While looking for someone to accuse as responsible for present conditions, we would, if we were strictly honest, take some of the blame ourselves for as the citizen owners of the property we have been too much occupied with other affairs to give enough thought to how our natural resources are being used, and in the cases where we have permitted misuse we take the easy way of salving our sense of guilt by placing all the blame upon the exploiters of our property.

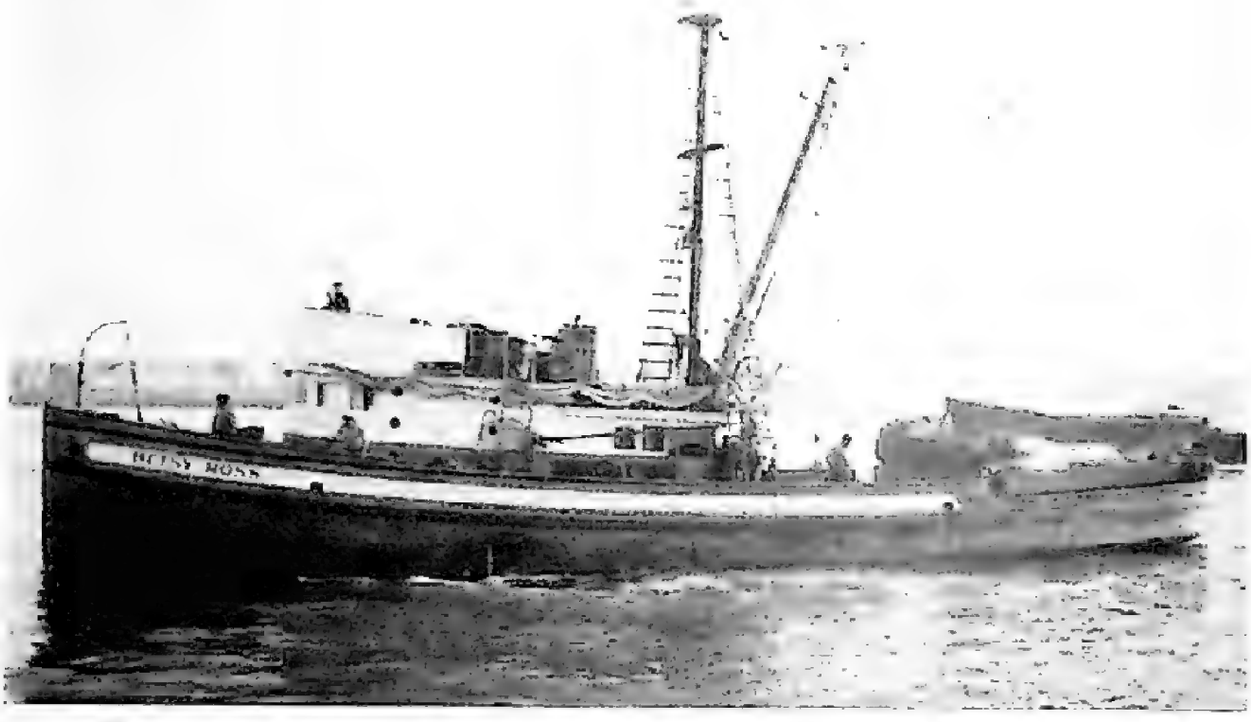

FIG. 120. Purse seine boat at San Pedro, California.
Photograph by Richard S. Croker.

Some of us have advanced the argument that the dust bowl in the Middle West was caused principally by plowing too much area of prairie land, thus allowing the wind to blow away the soil. The steel plow did this work, but is the remedy now to go back to plowing with a forked stick and discard the steel plow, or does the fault lie in unregulated plowing? Is the efficiency of the steel plow to be condemned or should we regulate the operator of the plow?

We have been answered that this line of reasoning does not apply to commercial fishing in California. The purse seine is the principal net used in sardine and mackerel fishing, and both of these species are being depleted seriously. We are asked why purse seine operators have not been regulated in the past and what assurance we have that adequate regulation will be applied in time to prevent the collapse of these two greatest fisheries of the State. We are told that the way to

save these fisheries is to abolish the overly efficient net that is depleting the supply, and that legislation can be passed to eliminate the net, but that adequate regulation of the amounts caught by purse seines could not be accomplished because of public apathy and pressure politics by a minority group.

We find it difficult to answer this convincingly but our reply is that some of the other fisheries in this State have been properly regulated without discarding the efficient gear. We suggest that the amount of the annual catch could be adjusted by a statewide total bag limit rather than hamper the fishery by compelling the use of less efficient gear that would increase the price of the fish to the consumer. Total catch may be, and often is, reduced indirectly by limitation of the season open to fishing, areas closed, and regulations as to permissible sizes of fish.

Limiting the size of purse nets seems to us a useless begging of the question and probably would accomplish very little of real value. It would be only an aggravating handicap to fishing operations, would increase costs needlessly and alone would not safeguard the supply from overfishing. Increased fishing effort could make possible the continuance of excessively large catches in spite of the restricted size of the net, so that limiting net size only does not appear to offer a solution to our sardine and mackerel problems.

Some sportsmen who fish on the ocean wish purse seines eliminated because they compete or interfere with ocean angling. This antagonism between sportsmen and commercial fishermen was recognized when certain areas were set aside for the exclusive enjoyment of sportsmen, but another approach to this question is to limit the use of purse seines to the species of fish used for canning, which would eliminate to a large extent the friction between sport and commercial fishermen. The purse seine is a net designed for large scale operations so there is little justification for its use in small volume fisheries. Purse seining of such game species as barracuda, white sea-bass and yellowtail antagonizes sportsmen, floods the fresh fish markets, and is generally looked upon with disfavor, so that prohibiting purse seining for these species is advocated by most people, including a majority of the purse seine operators themselves.

Another argument advanced against the purse seine is that it catches all sizes of fish, whereas with gill nets the size of the mesh openings may be regulated so as to capture only fish within a limited size range and avoid catching other sizes. It is suggested therefore that the sardine fishery of this State should return to gill nets, which would:

1. Reduce the total catch from the present excessive amounts.

2. Raise the price paid to fishermen, thus eliminating the profit in sardine reduction plants so that the catch would be used for canning and not converted into oil and meal, the practice responsible for the present depletion of supply.

3. Limit the catch to adult sardines that had made their contribution toward perpetuating the species by having spawned two or more years.

We must agree that a return to gill net fishing would reduce the total sardine catch, undoubtedly would eliminate reduction plants, and could govern the sizes of fish in the catch by adjusting the size of mesh in the gill nets. The sudden limitation of this fishery to gill netting would be very drastic and heroic treatment for present ills, and we question the desirability of arriving at the above mentioned three goals in the manner necessitated by the use of gill nets. If sardine fishing should be confined to gill nets only, the quantities of fish caught would

FIG. 121. Purse seine boat on the ways for overhaul. Fish Harbor, Terminal Island, California. Photograph by Richard S. Croker.

be so greatly reduced that only a small volume of high-priced product could result. It is doubtful if the gill net catch:

1. Would be in sufficient volume to support canning operations,

2. Would be low enough in price to permit the canned product to compete with other canned foods, or

3. Would fully utilize that portion of the sardine supply that could be taken safely each year without causing overfishing.

The cure might be so severe that it would kill the patient. It would seem that our sardine fishery might be sensibly managed without resorting to such extreme and probably unnecessary measures. Up to the present, the evidence indicates that our remaining sardine supply is sufficient to support, without overutilization, a reasonable canning industry. Apparently, it would not require an excessive quantity of sardines to maintain a canned pack equal to the average pack of past years, provided of course that all the catch would be used for canning.

There remains the proposal to take only the larger sardines by use of gill nets of the proper mesh size. In this fishery the legally open season readily can be adjusted so as to confine fishing to the winter

months when the large mature sardines predominate in the catch. A resort to gill nets would not be necessary in order to regulate the sizes of fish caught. Furthermore, if the catch was an amount comparable with the annual replacements of young fish and if we were maintaining a normally stable breeding stock in the ocean, it would not be a serious consideration whether the annual catch was made up of large sardines or mixed sizes. The relationship between the amounts of fish harvested and the replacements from spawning is the question of greatest concern.

These are a few of the disputes over purse seining in this State and only the high spots of these few are touched upon here, for the questions have many complications and furnish subject matter for argument far into the night. We are confronted with serious depletion in our two largest fisheries, those for sardines and mackerel. In the management of the State's fisheries resources, we need to face the facts and intelligently carry out our policy already adopted—that of business-like management on a basis of sustained yield, by balancing harvests against replacements so as to maintain a full breeding stock in our waters. Fisheries management can not legislate the abundance of young fish that shall be spawned. The annual catch *can* be regulated and in this way the breeding stock in the ocean can be built up or depleted, which in turn influences the abundance or scarcity of the young fish spawned by the breeding stock. The key is proper control of the amounts harvested each year. If the volume of annual catch is held to the proper limit, it will make little difference how the proper amount is harvested. It would seem therefore that sound economics would call for the limited harvest being gathered by the cheapest and most efficient fishing gear possible so that at least a part of the saving in production costs could be passed on to the consumer.

THE CRAB INDUSTRY AT EUREKA [1]

By Leslie E. Lahr
Bureau of Patrol and Law Enforcement
California Division of Fish and Game

The crab fishery at Eureka in Humboldt County, which was formerly a small local business, is gradually being developed on a larger scale with the establishment of crab packing plants, under a decision of the courts that crabs brought in from outside the three-mile limit are not subject to the law which prohibits shipment of crabs from the Humboldt County districts. The first plant began its operations as soon as weather permitted after the opening of the 1938-39 crab fishing season, and has operated steadily as the weather and the market

Fig. 122. Trap used for catching crabs off Eureka. Although these traps are legal in State waters in the districts off Eureka, it is illegal to ship out of these districts any crabs taken inside the three-mile limit. Hence most of the trap fishing is carried on outside this limit. Crab traps are lifted twice a week. Photograph by Leslie E. Lahr.

for crab meat allow. Due to the frequently impassable condition of the bar at the entrance to Humboldt Bay, it is sometimes impossible for boats to cross over to the outside crab fishing grounds.

[1] Submitted for publication, August, 1939.

The jig boats which ordinarily troll for salmon are being used for crab fishing in Eureka. These boats are of about the same size and type as the San Francisco crab boats, and range in length from 20 to 40 feet with engines of 8 to 16 horsepower. These boats use both traps and the ordinary hoop nets.

The traps, used for "crabbing" in deep water outside the three-mile limit, are built over a welded steel frame. (See Fig. 122.) The frame is wrapped with strips of rubber, cut from discarded automobile inner tubes, to prevent galvanic action from destroying the woven copper wire mesh that covers the trap frame. A fyke is woven into the trap on each side and a large hinged lid provides an easy exit for the removal of the catch. These traps are circular in shape, 40 inches in diameter by 14 inches deep, and are used in 17 fathoms of water, more or less, depending on the location, as the depth of the continental

FIG. 123. A standard crab hoop net of the type used at San Francisco and Eureka. Position *A* on the left demonstrates the trap in collapsed state when in fishing position on the ocean bottom. Position *B* demonstrates how crabs, attracted by the bait in the center, are trapped when the net is lifted. Photograph by J. B. Phillips.

shelf varies considerably off the coast of Humboldt County. The lines are about ¾-inch diameter hemp and are buoyed by eight 4-inch and two 2-inch corks. The upper or marker buoy is usually a gallon glass jug. This type of float is to prevent fouling of the boat's propeller as any rough usage will break the jug, allowing the line to sink below the propeller. The next lower float holds the line near enough to the surface to make recovery of the trap comparatively easy. Due to the heavy pull of the tide it is necessary to use about 26 fathoms of line to operate traps in depths of 17 fathoms. These traps are constructed by the fishermen themselves at a cost of about $15.00 each. Most of the boats fish with 15 to 30 traps, but a few have as many as 80. This is probably the first time this type of trap has been used to any large extent in California, although it has been in use for some time in Oregon and has had occasional use in this State.

The ordinary crab net or "ring gear" is used more than the traps by the Eureka boats because it is much cheaper. This net consists of a circular iron hoop, about 33 inches in diameter, and a smaller hoop inside, with cotton webbing between the hoops and a wire bait container in the inner hoop. The main lifting line is fastened to the outer hoop by three-point suspension.[2] (See Fig. 123.)

FIG. 124. A deep-sea patriarch. This exceptionally large crab measures nine inches straight across the back. Handling the live crabs requires a firm grasp and a quick hand. Nearly every fisherman has suffered at least once from the strong "claws," and many bear scars and mutilated fingers as constant reminders of caution. Some fishermen are so deft that they are able to handle as many as six crabs with one hand. Photograph by Leslie E. Lahr.

The crab packing plant consists mainly of a large cooking vat and packing room where the cooked crabs are prepared for market. The cooking system developed some new and unexpected angles when the new redwood cooking vat originally installed stained the boiling water a pink color and rendered the first few crabs cooked unfit for the market, due to the unusual color. This redwood vat was immediately replaced by one made of spruce, that has proved satisfactory. The heating plant is a large boiler similar to those used on donkey engines. The live steam from this boiler is piped to the vat where the water is brought to a boil for the actual cooking process.

After delivery to the plant, the fresh crabs are sorted as to size; those measuring 7½ inches or more across the back of the shell are classified as "jumbos" and sold whole. Small crabs are rarely seen at Eureka and the dealers as a rule refuse crabs measuring less than 7½ inches (the legal minimum size is 7 inches). These large crabs are first placed in specially constructed galvanized iron baskets holding 15 dozen, or about 360 pounds, raised by a chain hoist to the height of the rim of the furiously boiling cooking cauldron, moved into position

[2] For a full description of the hoop net and its operation, see "The crab fishery of California," by J. B. Phillips; California Fish and Game, vol. 21, pp. 38-60, 1935.

directly over the vat, and quickly submerged beneath the boiling water. Sufficient time is allowed for the water to return to the boil, and about 20 to 22 minutes of actual cooking then takes place. When the crabs are thoroughly cooked, the basket is removed via the chain hoist, moved a short distance along the overhead rail and again plunged into water; this time for the purpose of cooling and washing the cooked crabs. The crabs are then removed from the cooking basket, packed into large shipping boxes and iced for shipment.

The procedure for cooking crabs to be "picked," i.e., removing the meat for packing, differs slightly. Before being packed in the cooking basket, the crabs are "butchered"—the shell is removed, the waste parts cleaned out, and the body of the crab broken in half longitudinally. (Anyone who has ever handled a large and active crab can appreciate this task.) After butchering, the crabs are placed 30 dozen to the basket and cooked from 16 to 18 minutes. Upon removal from the cooking vat, the cooked crabs are rinsed in cold water which loosens the meat and expedites picking. The crabs are next sent to the crew

FIG. 125. Cracking and picking crabs at a Eureka crab plant. The workers stand on a wooden grating laid over the cement floors. The large cans are for receiving the empty shells. Photograph by Freeman Art Studio, Eureka.

that cracks the heavy, hard shell of the claws and legs with wooden mallets to permit extraction of the meat. The picking crew next takes over and removes the meat from the shells. After picking, excess moisture is drained off. This was formerly done by placing the meat in slightly sloping trays (see Fig. 126), but centrifuges are now used

for draining. The drained meat is packed in parchment-lined tin cans holding five pounds each.

The finished product is very attractive in appearance and delicious to the palate. The meat in the cans is usually whiter than that obtained by cooking the crab whole, and also is of a milder flavor.

After packing, the cans are placed in large fish boxes, covered with cracked ice, and shipped by express to nearly every city in the West. The best markets are in Salt Lake City, Los Angeles, Sacramento, Bakersfield, San Francisco and San Diego.

Cleanliness is very evident at the crab plants. The City of Eureka health officer must inspect the plant and equipment thoroughly and be satisfied that sanitary conditions prevail before a permit is issued to

FIG. 126. The picked crab meat laid out on slightly sloping trays to drain off any excess moisture before packing in five-pound cans. This draining method has been discontinued and the crab meat is now drained in a centrifuge. Photograph by Freeman Art Studio, Eureka.

operate. The women "pickers" employed are required to wear rubber gloves, aprons and a suitable head covering while at work. All equipment—pans, cans, mallets and utensils—are daily sterilized by thorough boiling.

The economic possibilities of this new industry are indeed interesting. During the first three months of operation over 4000 sacks of crabs (two dozen to the sack) were utilized, the price ranging from $1.25 to $1.75 per dozen, or approximately $11,000 for crabs purchased from about 45 fishermen, operating the 35 fishing boats necessary to keep an adequate supply of crabs at hand. In addition to nets, lines and other gear, each boat uses about 35 to 40 gallons of fuel per week

and from one to two gallons of lubricating oil. Other items that require considerable expenditures are bait, either herring or shad when obtainable, of which each boat needs about 50 to 60 pounds per day, food for the crew, engine parts, paint and waterproof clothing.

During the first few months of the 1938-39 season, nearly $4,000 was paid for labor in one plant to the five men and eight women employed. The women pickers were all inexperienced at the beginning and averaged about forty cents an hour, receiving five cents per pound for their work. At present pickers average nearly seventy cents per hour, with the faster workers earning as much as eighty-three cents per hour for an eight-hour day. This plant represents an investment of approximately $3,500. With the present equipment, between 125 and 130 dozen crabs are utilized each day, yielding about 900 pounds of meat.

Another company is also operating in Eureka, though on a smaller scale than the above described plant. The methods used are similar except that the crabs are cooked in a specially constructed cook house a short distance from the packing plant, and are then transported by automobile to the packing plant.

With all this new activity, it is only natural to expect a marked effect on the fishery. However, no adverse effects have been felt as yet, as all the fishermen using traps in the outer districts are maintaining their gear in its original location, with the catch remaining at the same level as when the traps were first placed. There is also no apparent change in the size of the crabs as there is a very plentiful supply of "jumbos." As the minimum size limit is seven inches, and no female crabs may be taken, the catch is limited to the surplus large males so that the danger of overfishing is minimized.

NINTH ANNUAL BLACK BRANT CENSUS IN CALIFORNIA [1]

By JAMES MOFFITT
California Academy of Sciences

The ninth consecutive annual census of black brant (*Branta bernicla nigricans*) was conducted from February 13 to 15, 1939, on the California bays frequented by this species, except on Tomales Bay, where it was taken on February 17. These dates are somewhat later than those upon which most of the previous annual counts have been made, February 10-12, but they are not considered to be so delayed as to materially affect comparative values of the censuses. The fact that the annual convention of the Bureau of Patrol, California Division of Fish and Game, was this year held in Sacramento on February 10 and 11, prevented the wardens who cooperate in the brant census from participating before February 13.

The game wardens mentioned later, who have assisted with previous annual censuses, are again thanked for their continued cooperation. Grateful acknowledgment is also made for the assistance of Dr. R. T. Orr of the California Academy of Sciences with the Tomales Bay count, and to Dr. A. P. Marshall and Major Allan Brooks for taking the census at Morro Bay.

Because previous experience has indicated that our mid-February censuses are made before maximum brant concentration obtains on California bays, the game wardens this year made supplementary population estimates at later dates. The results of these observations, which are incorporated in the regional reports which follow, fully bear out this fact. Mid-March appears to be the average date for maximum concentration on California bays, hence this would be the most desirable time for census taking. However, since nine annual counts have been made in February, it is planned for comparative purposes to continue with the original dates next year, at least, in order that a ten-year record may be available.

Besides the February and March census results, the following regional reports include such miscellaneous information regarding brant as has been forthcoming during the past year.

Humboldt Bay

Captain of Game Wardens J. D. Dondero, Eureka, made the 1939 observations at this point, as he did the previous year. Counts were made on February 13, 14 and 15, 1939, with the conclusion that 29,000 brant were then present. This total is below the previous seven years' average for the locality and is considerably less than the February 10, 1938 estimate of 45,000 birds. Captain Dondero advised that this year

[1] Submitted for publication, September, 1939.

the brant appeared to be in good condition and none was seen to visit the fields to feed, as was reported in 1938. Eel grass conditions were good in Humboldt Bay this year, save for about a 100-acre plot that was covered with mud by a dredging operation in South Bay. Apparently the supply of eel grass, the brant's favorite food, was ample on Humboldt Bay this year to accommodate the relatively few birds present, while observations in 1938 tend to indicate that a food shortage existed for the larger number of brant then concentrated.

Captain Dondero later advised that maximum numbers of brant, in excess of 100,000 birds, were present on Humboldt Bay from March 15 to April 1, 1939. This total agrees with the previous year's maximum, reported by the same observer for March 13, 1938. Captain Dondero remarked that the birds appeared to be late in leaving for the North this spring, at least 25,000 being present as late as April 19, 1939.

Bodega Bay

Game Warden Bert Laws, Petaluma, counted the brant on this bay on February 13, 14 and 15, 1939, where he made the previous census on February 12, 1938. Respectively 1100, 1075 and 1115 brant were recorded on these three days, but Laws felt that possibly more birds may have been in the region, as operations connected with raising a sunken fishing boat in the lower part of the bay disturbed the brant in that vicinity. The 1939 totals are averaged as 1100 brant, which is somewhat less than the seven-year average for the area and for the previous two seasons.

Laws again counted the brant on Bodega Bay on March 31, 1939, when a satisfactory census revealed 1180 birds present. Fishermen that day told Laws that there had been more brant on Bodega Bay two weeks earlier, so the time of maximum concentration here appears to agree with that for Humboldt Bay. The same fishermen reported eel grass as recently becoming scarcer on this and on Tomales Bay, a condition which, if continued, bodes ill for our wintering brant, hence should be watched with concern.

The writer passed by Bodega Bay at 8 a.m., April 16, 1939, where at least 750, possibly 1000, brant were observed. The birds apparently left for the north that day, for Commander Parmenter (Bird-Lore, vol. 41, 1939, p. 194) records only 300 as being present on April 17. The same observer (*ibid.*, p. 262) reports 73 brant on Bodega Bay, May 1, 1939.

Tomales Bay

Dr. Orr and the writer attempted to take a census at this point on February 10, 1939, the usual date for the locality, but were frustrated by outboard motor trouble. February 17 was our next opportunity to make a count, at which time a satisfactory census of 9241 brant was obtained. This total is exceeded for the nine years in which censuses have been made on this bay, only by the first, or 1931, count when 9445 brant were recorded. Possibility exists that there actually were several hundred more brant present on Tomales Bay than the census indicates for this year, as counting was difficult because of concentration of the birds near Hamlet and our estimates leaned heavily toward the conservative side.

It appears that the 1939 census total represents about maximum February concentration for brant on Tomales Bay, where 10,000 birds probably represent maximum carrying capacity of the bay. Residents report greater numbers of brant present for only a few days at a time, during the mid-March premigratory concentrations, when perhaps 15,000 birds may tarry for a brief interval; but accurate counts of such magnitude are lacking. It is regretted that we could not arrange for a mid-March census on Tomales Bay this year.

Noteworthy as further indicating the preference of brant to feed on eel grass, upon which Pacific herring (*Clupea pallasii*) have deposited their eggs, were our observations of February 17, 1939. This habit has previously been mentioned in the third census report (California Fish and Game, vol. 19, 1933, p. 255). Opposite Blakes Landing a mile south of Hamlet on the eastern shore of the bay, we found a concentration of 1680 brant, and many surf and white-winged scoters, and greater scaup ducks, feeding close to shore in the moderately high water of a rising tide between 7.30 and 8.00 a.m. These birds were making the water foam by their feeding activities along a stretch of shore line 300 yards long. They were indiscriminately mixed as to species in a milling mass extending almost from the shore to from 25 to 75 yards out into the bay. Visibility was excellent from the 50-foot cliff bordering the shore at this point whence the birds' activities were studied for some time. Beds of eel grass here closely parallel the shore line, over which the birds were feeding. The ducks dived repeatedly and in their underwater activities of, no doubt, gathering free-floating herring spawn, often drove herring to break the surface. The brant fed upon the eel grass, to which herring eggs were unquestionably adhering, by tilting up, "surface-feeding duck-like," and reaching their long necks down for the plant.

That the brant actually prefer to feed on eel grass upon which herring eggs are deposited was indicated by the stomach contents of 20 brant shot on Tomales Bay, December 30 and 31, 1932. Examination showed that in most cases the stomachs and gullets of these birds contained eel grass that was heavily coated with herring eggs. The stomach of one of these birds, kindly examined by Dr. Clarence Cottam of the U. S. Bureau of Biological Survey, was very full and contained 27.7 c.c. of food and 8.5 c.c. of gravel. In percentage of bulk, animal matter consisting of fragments of approximately 6000 small fish eggs, presumably those of the Pacific herring, comprised 26 per cent, one amphipod and one isopod, one per cent of the total. Vegetable matter made up the remaining 73 per cent of the stomach content bulk, of which 63 per cent was pieces of eel grass, some one-half inch wide and 16 inches long, and 10 per cent leafy fragments of the closely related surf grass (*Phyllospadix*), one piece 18 inches long. The long pieces of these plants are neatly folded or "pleated" by the birds in feeding into compressed wads before they are swallowed. The flesh of some of these brant that were eaten had a disagreeable, fishy taste, indicating that the birds had taken considerable spawn. Local hunters on Tomales Bay are well aware that the brant prefer to feed on beds of eel grass where herring have recently spawned.

A visit to Tomales Bay on April 23, 1939, revealed between 300 and 400 brant still present. Commander Parmenter (*op. cit.*, p. 262) reports 86 brant for the Bay on May 1.

Observations of Henry J. Jensen, a resident of Hamlet, on Tomales Bay, indicated that there was an unusually large and early fall flight of brant in 1938. Approximately 2000 birds appeared in the bay about November 3, where they remained until the 11th, to leave in a body that day. No brant was then observed until November 23, when Jensen claimed about 1500 arrived. Peter Scott and the writer gunned for brant on the bay on November 26, when we estimated that there were between 1200 and 1500 birds in the region. It appears that these individuals probably remained for the winter, and that their numbers were gradually augmented. On December 28, 1938, Major Allan Brooks and the writer found about 3,000 brant on the bay.

The fact that there is apparently an early autumn (October and early November) southbound flight of brant along the California coast that passes on, has been mentioned in several of the previous brant census reports. Brant arriving on our bays before mid-November appear to remain for a few days at the most, then they continue southward, presumably to Lower California. Brant which reach our bays during the latter half of November appear to remain with us until spring. Their numbers are gradually increased, apparently by migrants from the north, until early January, when populations are normally from one-third to one-half of mid-February numbers. Commencing early in January, and continuing until maximum concentration is reached in mid-March, large numbers of brant come to our bays, apparently entirely from the south. This curious, midwinter, northward movement of the birds has been stressed with many instances of confirmation in several of the previous census reports.

Drake's Bay

Game Warden R. J. Yates, San Rafael, who last year counted the brant on this bay which includes what is variously known as Limantour Bay or Drake's Estero, cooperated similarly on February 13, 14 and 15, 1939. High winds that prevailed in the vicinity over this period rendered accurate counting difficult as the brant sought protection in every sheltered cove and were thus much scattered. Yates considers that his average result for the three days, 6400 brant, may represent an underestimate by nearly a thousand birds. Nevertheless, this figure is by far the largest of eight annual counts made in the area, so it apparently indicates unusual concentration. The previous seven-years' average for Drake's Bay is about 2,000 brant and the highest former count was 3,500 birds in 1938. If brant are increasing in numbers in the Bodega-Tomales-Drake's bay area, the present large Tomales Bay count and the unusual one for Drake's Bay indicate that the greatest increase is at the latter point. Since Tomales Bay appears to have held this year about maximum numbers of brant, it seems probable that food conditions are better able to accommodate increases at Drake's Bay than elsewhere in this region.

Game Wardens Laws and Yates again counted the brant on Drake's Bay, March 31, 1939, when 9750 were estimated present. Yates

reported that there were certainly several thousand more brant, perhaps 15,000 all told, on Drake's Bay about March 15, 1939, when, however, he was unable to secure an accurate estimate.

Morro Bay

Major Allan Brooks, the well-known Canadian bird artist and ornithologist, who was visiting at Morro Bay, and Dr. A. P. Marshall of San Luis Obispo, who has helped with several previous censuses at this point, counted the brant of the vicinity on February 13, 1939.

Dr. Marshall reported securing a very satisfactory census, notwithstanding the large number of brant present. The count was made from 11 a.m. to 2.15 p.m. while the tide was falling. The weather was clear, calm and warm and the birds remained quiet, scattered in large groups over the entire bay, save its easternmost indentation. During the census, two flocks of about 40 brant each were observed to come to the bay from the ocean. No brant was seen to leave the bay.

So careful a census by two experienced observers under ideal conditions must be regarded as being highly accurate. The result was 11,140 brant, which represents nearly 50 per cent more birds than the 1935 result of 7544 brant, which was the highest of the seven previous counts at Morro Bay. Since 1936, the censuses here have increased gradually from 5000 that year to 5738 last year, so the present result indicates unusual concentration.

Game Warden F. W. Hecker of San Luis Obispo counted 6400 brant on Morro Bay on January 16, 17 and 18, 1939. Dr. Marshall estimated that there were less than 5000 birds present on January 22. The writer spent the morning of January 27 on Morro Bay with Major Brooks and Dr. Marshall, when there appeared to be about 5000 brant present. Three days later, these gentlemen estimated that 6000 brant were on the bay. Arrivals must have been numerous during the ensuing two weeks to produce the concentration recorded by the census of February 13. Unfortunately, no information is available concerning Morro Bay brant populations after this date in 1939.

Dr. Marshall reported that the present census result represents the largest concentration of brant that he has observed on Morro Bay in his many years of experience. His next largest count, nearly 10,000 birds, was secured on January 30, 1938, but many of these birds had left the region by February 12, when the regular census revealed that only 5738 were present.

The above information suggests that earlier maximum brant concentration obtains on Morro Bay than on the more northern California bays, frequented by the species. This is just what we may expect, if, as appears to be the case, our brant arriving after early January come from the south.

Mission and San Diego Bays

Game Warden E. H. Glidden, San Diego, who has conducted several previous censuses on these bays, took the 1939 count on February 14. The results indicated that there were 570 brant on Mission Bay and 462 on San Diego Bay. As in former years, activities of Navy

airplanes disturbed the brant on San Diego Bay during census taking. In spite of this disturbance, the result for each bay is the largest obtained in any of the nine annual counts and seems to indicate a gradual repopulation of the area by brant.

Glidden later reported his observations of brant on these bays for March and April as follows: March 17, 300 brant on San Diego Bay; April 3, 350 brant on Mission Bay; April 14, 120 birds on Mission Bay and 265 on San Diego Bay.

The following table presents a summary of the results of the nine annual brant censuses.

TABLE 1

Recapitulation of the California Black Brant Census, 1931-1939

Locality	1931	1932	1933	1934	1935	1936	1937	1938	1939
Humboldt Bay	Unsatisfactory	29,415	5,000	16,860	115,000	50,000	22,500	45,000	20,000
Bodega Bay	None made	3,200	977	1,208	3,700	350	1,500	1,475	1,100
Tomales Bay	9,445	6,285	7,409	5,565	6,850	9,175	1,550	3,085	9,241
Drake's Bay	None made	2,108	318	2,189	1,995	1,500	1,500	3,500	6,400
Morro Bay	4,493	2,938	None made	3,895	7,544	5,000	5,331	5,738	11,140
Mission Bay	71	No birds	115	154	9	30	450	325	570
San Diego Bay	No birds	No birds	No birds	7	55	No birds	350	397	462
Totals	Incomplete	43,946	13,819	29,968	135,153	66,055	33,187	59,520	57,913

Brant at Carmel Bay in 1939

Mr. Laidlaw O. Williams, of Carmel, has kindly provided for publication here his observations of black brant at Carmel and elsewhere in Monterey County in the spring of 1939. This is the first year in Mr. Williams' many years of observation at Carmel in which he has found brant in numbers in the locality.

A single brant was observed at the north end of Carmel Bay on February 6, 1939. Five were seen here on February 21 and between 75 and 100 birds, on March 13. On April 14, 183 brant were counted here, 156 birds on April 19, and 68 on April 29. The brant apparently left in the ensuing few days for none was seen on May 4. On April 19, Mr. Williams observed the brant to be feeding on a green ribbon-like plant which they secured from rocks by dipping their heads under the surface. The observer states that it was not eel grass and it seems probable that it was *Phyllospadix*, a closely related plant upon which brant are known to feed.

Williams felt that the brant observed in Carmel Bay from March 13 to April 29 were likely the same flock, the total number of which exceeded his combined previous counts for the region.

Some late seasonal observations for Monterey County were also afforded by Williams as follows: a mile or more off Cypress Point, 2 birds on May 7; Moss Landing, 4 brant on May 28.

Summary

Due to unavoidable circumstances, the 1939 black brant census was taken from one to five days later than in previous years, but the difference is not considered to be sufficiently great to destroy comparative values.

In point of total numbers, the 1939 result is a trifle larger than the average for the previous seven years. It is slightly less than the 1938 total. The difference is principally contained in the Humboldt Bay census which was below the seven-year average. Wide fluctuations are apparent in the previous counts made on this bay. The Bodega Bay count for 1939 is also somewhat less than the seven-year average. Elsewhere, at all of the more southern localities where censuses are made, larger than average counts were obtained this year. At Bodega, Morro, Mission and San Diego bays, the largest censuses thus far obtained were in 1939.

NOTES

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ANOTHER RECORD OF THE MONTEREY SPANISH MACKEREL

During the 1870's and on into the '80's, the Monterey Spanish mackerel, *Scomberomorus concolor* (Lockington) was one of the most esteemed and highly priced fishes to be found in the San Francisco markets. In the fall months of those years it appeared in Monterey Bay, never abundantly but at least in large enough numbers to be taken commercially. Then it simply disappeared, and for some forty years it remained unreported, at least in California waters. (It is possible that Boulenger's *Cybium concolor* from Panama is this fish. *See* Boll. Mus. Zool. Anat. Torino, 1899:3.) Definite proof that the species still existed came in 1927 when one was found in a San Pedro fish market. Two more appeared at Monterey in 1931, strangely enough on the same day, and in 1937 a sport fisherman at Long Beach caught one inside the harbor.

Capture of another specimen in Long Beach harbor on July 22, 1939, thus makes the fifth verified record of recent years. This fish, which was caught in a bait net, measured 50½ cm., standard length. It, like the first Long Beach fish, was a female with ripening eggs. Both are now preserved at the California State Fisheries Laboratory and are to be deposited in the Stanford University collection.

The basic mystery of why the fish disappeared and the question of from where the stragglers of recent years have come remain unanswered. All we learn from these occurrences is that somewhere the species still survives.—*Phil M. Roedel, State Fisheries Laboratory, California Division of Fish and Game, August 29, 1939.*

THE OCCURRENCE OF SAURIES IN SOUTHERN CALIFORNIA

The saury (*Cololabis saira*), also called skipper and garfish, is known to most commercial fishermen, though individuals are rarely brought into our fish markets. This fish, a member of the family Scomberesocidae, attains a length of 14 inches, but most specimens are less than 10 inches long. Though it is a pelagic fish, its eggs are not deposited in the open ocean. They are laid in strings of mucous in a manner similar to that of smelt and become attached to kelp or rocks. When seen in the water, the saury is easily distinguished from other bait-size fish by the manner in which it jumps from the water. Instead of leaping into the air frantically and blindly as most fish do when pursued, it makes one or more well-directed leaps. It is common for individuals not more than six inches long to make several two-foot jumps in rapid succession, scarcely going beneath the surface between jumps. This behavior is responsible for their being called "skippers."

They are considered a schooling fish although their schools are much less compact than those of sardines or anchovies. This fish is of considerable commercial importance in Japan, and it is so highly esteemed by the Japanese that it is shipped frozen from Japan to the United States for sale in the Japanese trade here.

The saury is not an uncommon fish along the coast of southern California. However, its appearance in large numbers is worthy of mention. The author was informed by fishermen on several albacore jig boats that there were large schools of small sardines south and east of Anacapa Island. In the course of the annual survey of small sardines, this area was covered on August 28, 1939 by the *N. B. Scofield*, fisheries research vessel of the California Division of Fish and Game. There was a large area of fish just south of Anacapa Island, but they were all sauries, not sardines. There was an estimated one hundred tons observed in this region alone. Along the south side of Santa Cruz Island and the north side of San Nicolas Island, there was an unusual abundance of sauries also, though not in the order of tons. Further surveys by the Division may show that the saury is much more plentiful in these waters than formerly suspected.—*J. A. Aplin, State Fisheries Laboratory, California Division of Fish and Game, September, 1939.*

REVIEWS

Between Pacific Tides

By Edward F. Ricketts and Jack Calvin. Stanford University Press, 1939. 320 pp., illus. $6.00.

As the title page says, this is "An account of the habits and habitats of some five hundred of the common, conspicuous seashore invertebrates of the Pacific Coast between Sitka, Alaska, and northern Mexico." The book describes the many interesting intertidal animals of the Pacific Coast from the standpoint of ecological relationship rather than taxonomic relationship. The result is excellent. Four principal classes of animals are considered: those of the protected outer coast, the open coast, bays and estuaries, and wharf piling. Each class, which is further subdivided, is the subject of a section of the book, and at the end of each section is a series of drawings and photographs depicting the animals discussed in the text.

An annotated systematic index and bibliography is appended. In addition to the references listed for the various phyla and orders of invertebrates, there is a short general bibliography. The list of references seems quite complete and is well annotated.

The authors are thoroughly conversant with their subject and this fact coupled with an easy style of writing makes for a most readable book. The reviewer found the whole text entertaining as well as informative, and once he overcame his prejudice against grouping illustrations instead of scattering them, he came to appreciate their excellence.—*Richard S. Croker, Editor, California Fish and Game.*

Animals Without Backbones, an introduction to the invertebrates

By Ralph Buchsbaum. Chicago, University of Chicago Press, 1938. 371 pp., illus. $5.00.

Although the book is beyond the scope of review in "California Fish and Game," we feel that the publication of "Animals Without Backbones" should not pass without mention in these pages. This textbook of the invertebrates is cram-full of facts presented in a pleasing fashion. Anyone who has an interest in animals, whether or not he has any scientific background, will profit from reading Buchsbaum's book. This is recommended reading matter.—*Richard S. Croker, Editor, California Fish and Game.*

In Memoriam

ERNEST V. CASSELL

On the morning of June 8, 1939, Superintendent E. V. Cassell was stricken with heart failure while on duty at the Mt. Shasta Hatchery. Mr. Cassell was one of the older and most valued employees of the Bureau of Fish Conservation and his loss will be most keenly felt by all.

He was born at Sacramento March 17, 1877. His first employment by the State as a fish culturist was at the Lake Tahoe and Tallac hatcheries in 1900. At various times when not employed by the State he worked temporarily for the United States Bureau of Fisheries at Baird, Battle Creek and Mill Creek until he qualified by civil service examination for permanent appointment in the service of the Federal Government. He served as fish culturist at Baird during the summer months and as foreman at the Mill Creek Station from time to time during the fall and winter. In addition, he assisted with experimental work with Captain Lambson at Boulden Island.

In 1910 he left the service of the Bureau of Fisheries and came to work for the Division of Fish and Game under the supervision of Mr. E. W. Hunt at Lake Tahoe. During October, 1911, he was assigned to take charge of the Brookdale Hatchery in Santa Cruz County. Between 1912 and 1920 his experience was varied since he was assigned work at Domingo Springs, Lake Almanor, Klamath River, and he also did some shad work on the Yuba River near Marysville. In 1920 the Fall Creek trout and salmon hatchery was completed and Mr. Cassell was assigned there as foreman in charge. As foreman of that station he also had charge of the work at the Klamathon salmon egg collecting station. In 1931 he was transferred to the Mt. Shasta Hatchery as foreman and shortly thereafter, following the death of Captain Lambson, he was made superintendent.

The Division of Fish and Game, and particularly the Bureau of Fish Conservation, will suffer through this loss of a conscientious and experienced employee. Mr. Cassell had many personal friends throughout the Division and his sudden death was cause for sadness to all of them. They join in extending their deepest sympathy to Mrs. Cassell and her son, Richard. —*A. C. Taft, Chief, Bureau of Fish Conservation, California Division of Fish and Game.*

CHARLES A. HOLZHAUSER

On September 2, 1939, Warden Charles A. Holzhauser, one of the youngest and most promising men on the staff, died. Mr. Holzhauser was born October 1, 1912, at Etna, California, where he attended school. He was appointed to the Bureau of Fish Conservation, July 1, 1936, with the rank of Assistant Warden, working in hatcheries and with

fish planting crews. He was transferred shortly afterward to cannery inspection in the Bureau of Patrol, in which bureau he remained, except for fish planting work in the summer of 1937, until the time of his death. He successfully passed a promotional examination and was appointed Fish and Game Warden on May 1, 1939. His headquarters were at Watsonville, Santa Cruz County, where he was on marine patrol. His death, from encephalitis, occurred while he was temporarily assigned to dove patrol at King City.

Mr. Holzhauser's death leaves a gap in the ranks of the patrol force and his co-workers will all miss him. We wish to extend our sympathies to his widow, parents and sisters.—*E. L. Macaulay, Chief, Bureau of Patrol and Law Enforcement, California Division of Fish and Game.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1938, to June 30, 1939, of the Ninetieth Fiscal Year

	Detail	Subtotal	Total
Revenue for Fish and Game Preservation Fund:			
License Revenue—			
1939 series, angling:			
Citizen	$280,414 00		
Nonresident	2,661 00		
Alien	8,615 00		
Duplicate	144 00		
Total angling		$291,834 00	
Deer tags		13 00	
Fish breeders		380 00	
Fish importers		85 00	
Fish packers and shell fish dealers, citizen		35 00	
Fishing party boat permits		377 00	
Fish tags		2,012 52	
Game breeders		1,200 00	
Game tags		121 14	
Hunting—			
Citizen	$76 00		
Junior	14 00		
Total hunting		90 00	
Kelp harvesters licenses		30 00	
Market fishermen		14,640 00	
Trapping, citizen		1 00	
Total 1939 series			$340,821 66
1938 series, angling:			
Citizen	$150,507 00		
Nonresident	4,369 00		
Alien	6,330 00		
Duplicate	643 00		
Total angling		$161,849 00	
Commercial hunting club, citizen		$950 00	
Commercial hunting club operator			
Citizen	$360 00		
Alien	25 00		
Total commercial hunting club operators		$385 00	
Deer tags		$138,938 00	
Fish breeders		10 00	
Fish importers		5 00	
Fish packers and wholesale shellfish dealers			
Citizen	995 00		
Alien	100 00		
Total fish packers and wholesale shell fish dealers		$1,095 00	
Fishing party boat permits		$191 00	
Fish tags		2,122 90	
Game tags		335 46	
Game breeders		155 00	
Hunting			
Citizen	$432,210 00		
Junior	23,949 00		
Nonresident	8,230 00		
Declarant alien	3,040 00		
Alien	1,775 00		
Duplicate	647 00		
Total hunting		$469,851 00	
Kelp harvesters		$20 00	
Market fishermen		49,810 00	
Trapping			
Citizen	$1,875 00		
Alien	38 00		
Total trapping		$1,913 00	
Total 1938 series			$1,127,630 36

STATEMENT OF REVENUE—Continued

For the Period July 1, 1938, to June 30, 1939, of the Ninetieth Fiscal Year

	Detail	Subtotal	Total
1937 series, angling:			
Citizen	$6,723 47		
Nonresident	—30 00		
Alien	50 00		
Duplicate	6 00		
Total angling		$6,749 47	
Deer tags		1,640 32	
Fish packers and wholesale shell fish dealers			
Citizen	$30 00		
Alien	20 00		
Total fish packers and wholesale shell fish dealers		$50 00	
Hunting			
Citizen	$14,949 50		
Junior	1,025 00		
Nonresident	60 00		
Declarant alien	30 00		
Alien	75 00		
Duplicate	28 50		
Total hunting		$16,168 00	
Trapping, citizen		14 00	
Total 1937 series			$24,621 79
1936 series			
Fish packers and wholesale shell fish dealers		$20 00	
Total 1936 series			20 00
Total licenses			$1,493,093 81
Other revenue:			
Court fines		$37,950 20	
Fish packers tax		329,933 09	
Kelp tax		423 38	
Lease of kelp beds		1,334 50	
Miscellaneous revenue		11,855 02	
Publication sales		305 19	
Salmon packers tax		16,616 59	
Sale of boat		4,700 00	
Warrants cancelled (Ch. 815-35)		10 40	
Total other revenue			$403,128 37
Total current year			$1,896,222 18
Prior year, 89th			
1938 series, angling:			
Citizen	—$2,097 70		
Nonresident	288 00		
Duplicate	—5 00		
Alien	—125 00		
Total angling		—$1,939 70	
Deer tags		—73 00	
Fish tags		46 67	
Game breeders		—2 50	
Game tags		—16 67	
Fish importers		—5 00	
Hunting			
Citizen	—$36 00		
Junior	11 00		
Total hunting		—$25 00	
Market fishermen		100 00	
Total prior year 1938 series			—$1,915 20

STATEMENT OF REVENUE—Continued

For the Period July 1, 1938, to June 30, 1939, of the Ninetieth Fiscal Year

	Detail	Subtotal	Total
1937 series			
Market fishermen		—$80 00	
Angling			
Citizen	$2,111 70		
Duplicate	5 00		
Nonresident	—288 00		
Alien	125 00		
Total angling		$1,953 70	
Deer tags		12 00	
Game breeders		2 50	
Fish packers and wholesale shell fish dealers		5 00	
Hunting			
Citizen	—$350 00		
Junior	—27 00		
Total hunting		—$383 00	
Trapping, citizen		81 00	
Total prior year 89th, 1937 series			$1,496 20
Court fines prior year 90th			—225 00
Grand total all years fish and game preservation fund			$1,895,508 18

STATEMENT OF EXPENDITURES

For the Period July 1, 1938, to June 30, 1939, of the Ninetieth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Operating Expenditures—90th Fiscal Year:					
Administration:					
Cashier	$1,710 00				$1,710 00
Executive	5,000 00	$371 77	$3,329 18		8,700 95
Exhibits	183 33		1,250 00		1,433 33
General office	7,495 00	3,280 80	55,261 82	$909 29	66,946 91
Legal			3,000 00		3,000 00
Library	1,920 00	54 44	153 40	1,455 36	3,583 20
Property inspection	2,814 20	199 05	434 19	168 18	3,615 62
Publicity			2,129 39		2,129 39
Fish and game magazine		3,077 23			3,077 23
Total Administration	$19,152 53	$6,983 29	$65,557 98	$2,532 83	$94,226 63
Patrol and Law Enforcement:					
Cannery inspection	$21,643 96	$898 73	$3,296 55	$9 97	$25,849 21
Executive	12,629 85	775 96	3,276 50	26 02	16,708 33
General office	6,030 00	1,191 03	925 45	684 27	8,830 75
Junior patrol	3,730 00	636 81	1,501 64	185 40	6,053 85
Land patrol	219,414 40	43,966 03	68,599 08	19,836 85	351,816 36
Marine patrol	78,211 34	27,197 20	47,329 33	10,707 87	163,445 74
Pollution patrol	10,554 51	2,217 75	4,398 88	622 57	17,793 71
M. V. Bluefin galley		302 12			302 12
M. V. N. B. Seofield galley		181 30			181 30
Total Patrol and Law Enforcement	$352,214 06	$77,366 93	$129,327 43	$32,072 95	$590,981 37
Marine Fisheries:					
Executive	$7,620 00	$209 14	$690 74		$8,519 88
Field supervision	3,300 00	311 26	1,066 80	$705 47	5,383 53
Fish cannery activities			4,346 32		4,346 32
General office	11,530 19	644 53	826 96	249 71	13,251 39
Research and statistics	49,550 09	6,995 37	25,028 55	5,304 37	87,778 38
Total Marine Fisheries	$72,000 28	$8,160 30	$32,859 37	$6,259 55	$119,279 50
Fish Conservation:					
Biological survey	$10,589 40	$1,274 07	$1,815 54	$2,558 84	$16,238 45
Executive	6,960 00	292 09	559 94		7,812 03
Field supervision	5,320 00	1,059 49	1,971 48	135 69	8,686 66
Fish planting	2,973 57	1,369 26	3,350 04	1,019 73	8,712 60
Fish rescue	10,095 16	601 81	3,422 47	616 30	14,725 74
Fish food unallocated		2,127 69	728 43		2,856 12
General office	5,160 00	827 19	445 55	1,074 88	7,507 62
Pollution inspection	4,530 00	671 09	821 16	919 31	6,941 56
Statistical	2,360 00	138 73	1,476 84	145 66	4,121 23
Stream improvements		100 55			100 55
Structural maintenance	4,158 39	1,052 54	1,498 23	989 97	7,699 13
Alpine Hatchery	2,365 17	824 83	213 18	685 62	4,088 80
Basin Creek Hatchery	4,998 35	3,698 33	459 12	2 09	9,157 89
Bear Lake Egg Col. Station	290 97	49	53 05		344 51
Benbow Dam Exp. Station	2,150 44	170 93	235 44	15 34	2,572 15
Blackwood Hatchery	10 00		1 00		11 00
Big Creek Hatchery	3,720 00	2,233 66	274 64	281 77	6,510 07
Blue Lakes Egg Col. Station	732 50	117 08	8 85		858 43
Bogus Creek Egg Col. Station	399 00	61 08	113 00		573 08
Brookdale Hatchery	3,635 49	1,388 92	567 28	23 94	5,615 63
Burney Creek Hatchery	6,328 47	2,509 69	493 69	58 93	9,390 78
Carmen Lake Egg Col. Station	332 91		38 62		371 53
Central Valleys Hatchery	3,939 00	2,123 06	1,710 73	355 53	8,128 32
Cold Creek Hatchery		16 02	125 25		141 27
Cottonwood Lakes Egg Col. Station	465 49	23 45	308 00		796 94
Fall Creek Egg Col. Station	1,966 67	540 30	92 84		2,599 81
Fall Creek Hatchery	5,090 46	4,289 11	260 07	90 06	9,730 30
Feather River Hatchery	4,490 99	3,404 12	712 94	536 22	9,144 27
Fern Creek Hatchery	1,653 30	380 61	23 00	623 94	2,680 85
Fishing Creek Exp. Station			150 00		150 00
Forest Home Hatchery	6,356 95	2,376 41	1,469 81	1,196 73	11,399 90
Fort Seward Hatchery	4,785 44	2,098 78	679 21	74 35	7,637 78
Hat Creek Egg Col. Station			25 00		25 00
Hot Creek Hatchery	4,042 36	5,069 68	457 87	15 95	9,585 86
Hornbrook Egg Col. Station	169 35	29 88	101 35	2 70	303 28
Huntington Lake	1,772 59	413 54	243 03	73 10	2,502 26
Hobart Creek Egg Col. Station		8 70	20 50		29 20
June Lake Egg Col. Station			33 45		33 45
Kaweah Hatchery	4,278 06	2,863 83	1,021 73	615 31	8,778 93
Kings River Hatchery	4,861 35	2,656 03	777 89	503 08	8,798 35

STATEMENT OF EXPENDITURES—Continued

For the Period July 1, 1938, to June 30, 1939, of the Ninetieth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Fish Conservation—Continued					
Klamathon Egg Col. Station	$1,205 80	$272 18	$593 64		$2,071 92
Lake Almanor Hatchery	6,394 78	2,949 86	1,233 42	$1,386 95	11,965 01
Lake Eleanor Egg Col. Station	245 49	22 70		$101 41	369 60
Lytle Creek Hatchery	632 66	81 28	85 99		799 93
Little Walker Lake Egg Col. Station	268 40		8 65		277 05
Little River Egg Col. Station	495 00	49 40	20 90	2 65	567 95
Madera Hatchery	2,389 79	1,600 50	273 26	32 87	4,296 42
Marlette Lake Egg Col. Station	665 23	14 31	23 80		703 34
Mt. Shasta Exp. Hatchery	1,865 00	734 65	34 37		2,634 02
Mad River Egg Col. Station	746 66	4 60	18 32		769 58
Mount Shasta Hatchery	34,426 17	22,341 91	3,771 79	2,809 98	63,349 85
Mount Tallac Hatchery	2,093 27	3,227 58	350 69	102 33	5,763 87
Mount Whitney Hatchery	12,504 82	4,871 60	2,238 71	1,903 19	21,518 32
Mountain Home Hatchery	2,380 33	947 79	1,559 31	33 62	4,930 05
Mud Creek Egg Col. Station	340 00	20 22			360 22
Pasadena Reservoir Egg Col. Station	207 69	25 30	44 67		277 66
Prairie Creek Hatchery	5,564 84	2,509 57	887 30	553 66	9,515 37
Rush Creek Egg Col. Station	529 19		14 78		543 97
San Lorenzo Egg Col. Station	134 00	30 18	55 12		219 30
Shackleford Creek Egg Col. Station	250 00	13 98	68 58		332 56
Scott Creek Egg Col. Station	1,020 00	458 54	64 22		2,142 76
Shasta River Experiment Station	150 00		98 17		248 17
Shasta River Egg Col. Station	955 29	79 12	109 54		1,143 95
Snow Mountain Egg Col. Station	4,183 16	533 42	511 80		5,228 38
Tahoe Hatchery	5,999 03	1,789 80	467 37	672 23	8,928 43
Upper Truckee Egg Col. Station	232 58	2 12	20 00		254 70
Waddell Creek Station	1,265 00	92 89	99 59		1,457 48
Yosemite Hatchery	4,266 96	1,378 76	444 67	52 39	6,142 78
Yuba River Hatchery	3,337 15	1,774 69	261 15		5,373 99
Total Fish Conservation	$216,519 12	$92,040 89	$40,123 63	$20,266 32	$369,549 96
Hydraulics:					
Engineering	$6,700 45	$802 01	$2,282 68	$802 57	$10,537 71
Executive	4,080 00	431 66	843 08		5,354 74
Fish screens		607 40		17 30	624 70
General office	2,040 00	197 23	386 92	178 02	2,802 17
Total Hydraulics	$12,820 45	$2,188 30	$3,512 68	$857 89	$19,379 32
Game Conservation:					
Elk Refuge	$1,820 00	$379 38	$585 57	$513 99	$3,298 94
Executive	13,140 00	1,386 76	3,034 14	906 56	18,467 46
Game bird distribution, Los Serranos	5,160 00	1,134 03	1,110 72	692 16	8,096 91
Game bird distribution, Yountville	4,835 03	2,617 35	1,740 92		9,193 30
General office	4,027 64	72 49	682 49	1,126 29	5,908 91
Grey Lodge Refuge	4,420 00	1,109 86	717 24	2,834 38	9,080 48
Imperial Refuge	2,560 04	233 75	118 51	102 32	2,963 62
Los Banos Refuge	4,010 33	655 81	937 59	3,156 50	8,760 23
Los Serranos Game Farm	13,520 99	2,981 76	3,240 86	594 76	20,338 37
Los Serranos Boarding House	192 00	478 63	13 41		684 04
Predatory animal lion hunters	5,527 11	637 30	8,662 72	15 58	14,842 71
Predatory animal trapping	31,180 30	8,020 08	7,967 66	4,155 73	51,323 77
Refuge posting		4 41			4 41
Research	3,091 51	855 38	2,191 22	49 57	6,187 68
Statistics	2,287 90	115 88	1,655 13		4,058 91
Suisun Refuge	2,972 24	599 63	486 96	137 13	4,195 96
Winter feeding and salting of game		260 25			260 25
Yountville Game Farm	15,186 13	8,240 55	2,892 96	1,177 78	27,506 42
Yountville Boarding House	1,320 33	1,459 03	44 97		2,824 33
Total Game Conservation	$115,200 55	$31,250 33	$36,083 07	$15,462 75	$197,996 70
Licenses:					
Executive	$3,480 00	$344 41	$1,487 50	$12 72	$5,324 63
General office	1,410 43	194 38	209 03	522 93	2,337 37
License distribution	12,011 44	21,421 06	65,911 35	1,377 35	100,721 20
Total licenses	$16,901 87	$21,959 85	$67,608 48	$1,913 00	$108,383 20

STATEMENT OF EXPENDITURES—Continued

For the Period July 1, 1938, to June 30, 1939, of the Ninetieth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Special Items:					
Construction of fish screens	$10,461 76	$17,136 95	$1,037 79	$3,456 74	$38,093 24
Construction of research boat	2,022 77	314 33	104 28	10,961 99	13,403 37
Construction of Russian River Jetty—all objects					55,000 00
Improvement of office, Ferry Building				500 00	500 00
Central Valley Water Project	3,313 95	1,371 99	1,960 11	970 12	7,622 17
Total Special Items					$114,618 78
Total 90th fiscal year expenses paid from support appropriations					$1,614,415 46
Prior year 89th fiscal years for support					*—485 80
Total 89th and 90th fiscal years for support					$1,613,929 66
Expenditures for Additions and Betterments:					
Permanent improvements:					
Purchase of game refuges and public shooting grounds and C. I. E., Ch. 157–37, 90th fiscal year	$6,466 81	$14,944 69	$1,670 92	$21,009 40	$44,091 82
Contributions to Employees' Retirement System					24,919 36
Total current biennium					$1,682,940 84

* Old deficit.

GAME CASES

April, May and June, 1939

Offense	Number arrests	Fines	Jail sentences (days)
Bird nets: possession	2	$12 50	
Brant: taking	1	25 00	
Coots: possession	2	30 00	
Deer: failure to tag, possession spike buck, doe, spotlighting, possession closed season, possession fawn, allowing does to run deer, venison in possession	71	1,690 00	737½
Doves: no license, overlimit, closed season, shoot from automobile	18	327 50	17½
Ducks: possession closed season, shoot before 7 a.m., sale, taking eggs, overlimit	27	810 00	74
Firearms: possession in refuge, discharge in refuge	7	55 00	
False statement to obtain license	5	80 00	
Geese: overlimit, possession closed season	5	60 00	
Hunting: no license, closed season, night, failure to show license	18	75 00	
Nongame bird: possession	1	10 00	
Pheasants: overlimit, closed season, female	17	625 00	
Pigeons: closed season	3		
Quail: closed season, no license, possession	4	112 50	
Rabbits: possession cottontails, closed season, no license	27	242 00	16½
Robins: possession	2	10 00	
Sagehens: closed season	1	25 00	
Totals	211	$4,189 50	845½

FISH CASES

April, May and June, 1939

Offense	Number arrests	Fines	Jail sentences (days)
Abalone: possession undersized red, green, black, out of shell, overlimit, closed season, no license	117	$2,032 50	30
Angling: no license, closed stream, failure to show license, false statement to obtain license, refuge	116	1,033 00	22½
Bass: possession black, calico, striped, white sea-bass, undersized, overlimit, closed season, night	116	2,205 00	156
Catfish: selling, closed season	1		25
Clams: undersized, overlimit, Pismo, selling, razor, Washington	49	702 50	400
Cockles: overlimit	14	175 00	5
Commercial fishing: no license, no boat numbers, no records	22	565 00	
Crabs: possession, undersized, female	14	175 00	54
Crappie: possession closed season	20	170 00	
Frogs: overlimit	1		
Fyke nets: in closed waters	3	25 00	
Halibut: undersized	1	20 00	
Lobsters: closed season, undersized, overlimit	4	45 00	
Nets: operate in closed waters, purse seine, closed waters	44	1,910 00	5
Perch: taking from closed stream	10	167 50	
Pollution	19	2,425 00	
Salmon: overlimit, undersized	2	40 00	
Set lines	21	545 00	15
Spear: within 300 feet stream	4	30 00	
Sunfish, bluegill: possession, overlimit	88	927 00	92
Transfer license	15	210 00	5
Traps	5	150 00	
Trout: overlimit, taking during closed season, no license, undersized, eastern brook, rainbow, steelhead, selling, prohibited gear	123	2,582 00	65
Tuna, bluefin: operating purse seine to take	4	1,075 00	
Tuna, yellowfin: no license	1	5 00	
Yellowtail: no license, overlimit, sale for salting	5	50 00	
Totals	819	$17,284 50	874½

SEIZURES OF FISH AND GAME

April, May and June, 1939

Fish:	
Abalone	693
Bass, black	93
Bass, black, lbs.	102½
Bass, striped	116
Bass, striped, lbs.	301
Catfish	8
Clams, gaper (horseneck)	148
Clams, Pismo	804
Clams, razor	2,500
Clams, Washington	197
Cockles	1,084
Crabs	139
Crappie	178
Halibut	11
Lobster	26
Perch	153
Salmon, lbs.	143½
Sea-bass, white, lbs.	4,599
Shad, lbs.	6
Shad roe, lbs.	190
Sunfish	396
Sunfish, bluegill	508
Traps, bass	40
Traps, lobster	29
Trout	336
Trout, eastern brook	77
Trout, Loch Leven	11
Trout, rainbow	21
Trout, rainbow, lb.	38½
Trout, steelhead	169
Tuna, bluefin, lbs.	59½
Tuna, yellowfin, lbs.	1,320
Yellowtail, lbs.	6,000

Game:	
Brant, black sea	1
Coots	4
Deer	5
Deer meat	1,227
Deer skin	3
Doves	20
Ducks	10
Pheasants	8
Pigeons	2
Quail	7
Rabbits	17
Robins	25
Sagehens	2

COMMERCIAL FISH LANDINGS IN CALIFORNIA BY FISHING BOATS

April, 1939

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Oregon waters	Waters south international boundary		Total landings by fishing boats
	*Regions 10 and 20, Del Norte and Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds	Regions 10 and 20, Del Norte and Eureka	Region 70, Los Angeles	Region 80, San Diego	
Anchovy			61,200	3,060		4,017		68,297				68,297
Barracuda					7,800	360,982	183,627	552,418			7,666	560,084
Cabezone			30	1,577	25			1,632				1,632
Carp		2,386						2,386				2,386
Catfish		38,242						38,242				38,242
Cultus, Pacific	21,133		25,987	8,111	226	24		55,481			429	55,910
Flounder, Starry	51,275		9,334	2,083				62,692				62,692
Grouper											2,001	2,001
Hake	200			150				350				350
Halibut, California			2,272	616	17,080	34,933	4,682	59,583			17,459	77,042
Halibut, Northern	77,080							77,080	175			77,255
Herring, Pacific					485			485				485
Kingfish			18	10,632	153	49,106	61	59,970				59,970
Mackerel, Horse				9,341				9,341				9,341
Mackerel, Pacific				23,988	170	28,504	10,265	62,936				62,936
Perch	1,209		10,589	10,488	2,100	8,280		32,676				32,676
Pompano, California						62		62				62
Rock Bass					2,807	5,919	1,188	9,914			4,395	14,309
Rockfish	100,888		39,127	158,051	26,070	41,965	9,329	385,030			15,553	400,583
Sablefish	27,741		404	823		16,433		45,401				45,401
Salmon	35,377	51,247		18,827				105,451	6			105,457
Sand Dab	33,455		8,351	7,909		566		50,281	175			50,456
Sardine			82,200	189,275	240	246,230	877	518,822				518,822
Sculpin						8,422	2,489	10,911			128	11,039
Sea-Bass, Black					3,192	1,111		4,303			5,127	9,430
Sea-bass, Short-fin							30	30				30
Sea-bass, White				417	4,782	50,458	6,766	62,423			1,075	63,498
Sea-trout, California	11							11				11
Shad		383,517		3				383,550				383,550
Shark	1,272		1,490	5,467	17,000	20,349	2,077	47,655			1,184	48,839

Sheepshead					681	3,926	82	4,689			410	5,108
Skate	9,160		2,075	3,404	905	640		17,084				17,084
Smelt	91		10,349	1,771	10,632	12,173		35,016				35,016
Sole	604,331		50,056	71,280	28,623	610	18	760,948	6,300			767,248
Split-tail		112						112				112
Tuna, Bluefin						291,759	1,071	206,730		199,793		406,523
Tuna, Bonito					115	100,501	258,321	364,937				364,937
Tuna, Skipjack										1,690,459	315,430	2,005,889
Tuna, Yellowfin										7,243,348	5,404,934	12,648,282
Turbot			6,691	361				7,052				7,052
Whitebait	26,432		2,991	1,881				31,304				31,304
Whitefish, Ocean					170	95		565			1,052	1,617
Yellowtail						88,998	7,068	96,066			62,069	158,135
Miscellaneous Fish	17,755		1,550	1,138	1,053	2,150		23,646				23,646
Crustacean:												
Crab	369,246		344,546	49,532				763,324	216			763,540
Crab, Rock						200		200				200
Shrimp			67,846	87				67,933				67,933
Mollusk:												
Abalone				136,025	88,050	386		224,461				224,461
Clam, Cockle			37		20	2,008		2,065				2,065
Clam, Gaper			407					407				407
Clam, Pismo				844	12,142			12,986				12,986
Clam, Razor	25							25				25
Clam, Soft-shell	48		6,037					6,085				6,085
Clam, Washington	1,243		571					1,814				1,814
Octopus	1,014		703	4,224		2		5,943				5,943
Oyster, Eastern			10,701					10,701				10,701
Oyster, Japanese			171,485		3,217			174,702				174,702
Oyster, Native			71					71				71
Squid				350,095				350,095				350,095
Total pounds	1,387,980	475,534	924,018	1,101,490	228,656	1,299,839	488,851	5,906,374	6,872	9,133,600	5,838,921	20,885,767

*The eight geographical regions of the State are as follows:
Regions 10 and 20, Del Norte and Eureka: Del Norte, Humboldt and Mendocino counties.
Region 30, Sacramento: Sacramento and San Joaquin river systems with the delta areas, including Suisun Bay and Lake County.
Region 40, San Francisco: Sonoma, Marin, San Francisco and San Mateo counties, including San Francisco and San Pablo bays.
Region 50, Monterey: Santa Cruz and Monterey counties.
Region 60, Santa Barbara: San Luis Obispo, Santa Barbara and Ventura counties.
Region 70, Los Angeles: Los Angeles and Orange counties.
Region 80, San Diego: San Diego and Imperial counties.
These tables are subject to slight revision due to belated supplemental items.

COMMERCIAL FISH LANDINGS IN CALIFORNIA BY FISHING BOATS

May, 1939

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Waters south international boundary		Total landings by fishing boats
	*Regions 10 and 20, Del Norte and Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds	Region 70, Los Angeles	Region 80, San Diego	
Anchovy			28,400	1,360		4,772		34,532			34,532
Barracuda					160	320,210	90,188	416,567			416,567
Cabezone				180				180			180
Carp		926						926			926
Catfish		5,421						5,421			5,421
Cultus, Pacific	33,962		17,373	10,001	152			51,488			51,488
Flounder, Starry	19,193		9,015	3,088				31,296			31,296
Flying Fish						2,653		2,653			2,653
Grouper										4,981	4,981
Halibut, California	305		1,333	699	20,346	24,040	426	47,149	8,367	19,477	74,993
Halibut, Northern	117,467							117,467			117,467
Kingfish			1,770	23,963	58	34,367		60,158			60,158
Mackerel, Horse				3,235		495		3,730			3,730
Mackerel, Pacific				21,466		40,258	8,051	69,805			69,805
Mullet						19	469	488			488
Perch				15		919		934			934
Pike		12						12			12
Pompano, California				31		34		65			65
Rock Bass					1,835	2,780	2,510	7,125		1,990	9,115
Rockfish	113,355		23,735	189,458	8,546	15,069	14,329	365,392	4,718	14,368	384,478
Sablefish	21,527		1,410	5,005		13,319		41,270			41,270
Salmon	253,127	279,446	13,610	4,983				551,166			551,166
Sand Dab	26,401		13,014	16,245		440		56,103			56,103
Sardine			39,700	282,045	80	7,908	865	331,198			331,198
Sculpin						9,659	3,677	13,336			13,336
Sea-bass, Black					1,331	4,736		6,067	1,990	8,878	16,635
Sea-bass, Short-fin							1,276	1,276			1,276
Sea-bass, White					982	30,519	3,213	31,714		2,830	37,544
Shad		821,379						821,379			821,379
Shark	1,030		605	3,810	570,161	56,126	1,535	633,267	1,086	492	634,845
Sheepshead					1,616	3,912		5,528			5,528

Skate	8,240		3,413	5,889	2,200	381		20,213			20,213
Smelt	264		3,834	1,727	2,560	14,538		22,923			22,923
Sole	640,660		81,172	118,597	20,095	347		861,171			861,171
Split-tail		40						40			40
Tuna, Bluefin						1,451,321	205,510	1,656,831	1,000,626	5,526	2,668,983
Tuna, Bonito						631,715	230,264	861,979	4,575		866,554
Tuna, Skipjack									2,265,622	808,307	3,073,929
Tuna, Yellowfin									6,201,866	4,654,013	10,858,819
Turbot	420		6,503	474				7,397			7,397
Whitebait	18,727		4,462	903				24,092			24,092
Whitefish, Ocean					235	59		294			294
Yellowtail						2,613	19,071	21,684		21,315	42,899
Miscellaneous Fish	16,145		771	2,015	566	16,621		36,118	24		36,142
Crustacean:											
Crab	303,968		373,212	16,962				784,142			784,142
Crab, Rock						96		96			96
Shrimp			95,506					95,506			95,506
Mollusk:											
Abalone				134,850	119,650	525		255,025			255,025
Clam, Cockle			59			2,406		2,465			2,465
Clam, Gaper			300	36				336			336
Clam, Pismo					14,674			14,674			14,674
Clam, Razor	40							40			40
Clam, Soft-shell	42		7,185					7,227			7,227
Clam, Washington	78		368					446			446
Mussel	1,800							1,800			1,800
Octopus	115		521	3,657		2		4,295			4,295
Oyster, Eastern			6,055					6,055			6,055
Oyster, Japanese			116,138		3,011			119,149			119,149
Squid				46,570				46,570			46,570
Total pounds	1,656,869	1,107,224	849,473	898,164	768,348	2,699,768	581,414	8,561,260	9,497,514	5,542,077	23,600,851

*See footnote to table for April.

COMMERCIAL FISH LANDINGS IN CALIFORNIA BY FISHING BOATS

June, 1939

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Oregon waters	Waters south international boundary		Total landings by fishing boats
	*Regions 10 and 20, Del Norte and Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds	Regions 10 and 20, Del Norte and Eureka	Region 70, Los Angeles	Region 80, San Diego	
Anchovy			11,340	300		4,045		15,685				15,685
Barracuda					135	412,017	93,591	505,743			240	505,983
Cabezone				198				198				198
Cabrilla										22,996	17,265	40,261
Carp		1,195						1,195				1,195
Catfish		5,048						5,048				5,048
Cultus, Pacific	16,536		10,004	4,125			42	31,307	1,450			32,757
Flounder, Starry	28,390		10,652	1,017				40,059				40,059
Flying Fish						4,098	114	4,212	*			4,212
Grouper										2,604	182	2,786
Hake	250							250				250
Halibut, California	50		489	2,818	13,325	41,486	372	58,540			3,771	62,311
Halibut, Northern	58,881							58,881	985			59,866
Kingfish			585	20,074	43	19,647		40,349				40,349
Mackerel, Horse				5,484		24,890		30,374				30,374
Mackerel, Pacific				10,739	599	1,057,912	817,385	1,886,635				1,886,635
Mackerel, Spanish											121	121
Mullet							86	86				86
Perch					3	867		870				870
Pompano, California				96		4		100				100
Rock Bass					7,750	20,771	8,733	37,254			3,966	41,220
Rockfish	24,847		16,482	156,269	9,500	30,222	30,114	267,434	1,326		3,344	272,104
Sablefish	22,492		640	10,169	23	6,471		39,795				39,795
Salmon	365,820	54,630	56,139	32,248				508,837	22			508,859
Sand Dab	30,998		27,033	8,479		477		66,987	3,810			70,797
Sardine			31,000	264,750	438	9,763	6,835	312,786				312,786
Sculpin					10	12,658	207	12,875				12,875
Sea-bass, Black					1,840	1,854	1,407	5,101		564	23,215	28,880
Sea-bass, Short-fin							1,259	1,259				1,259
Sea-bass, White					373	17,089	16,614	34,076			1,126	35,202

Shark	575		3,544	21,482	1,363,808	33,137	592	1,423,138			610	1,423,745
Sheepshead						493	5	498			1,399	1,897
Skate	8,280		5,803	3,766	2,285	1,467		21,601	130			21,791
Smelt	2,321		15,458	6,673	729	5,554	240	30,975				30,975
Sole	491,742		128,791	43,608	17,810	541	287	688,779	73,668			762,447
Swordfish, Broadbill						23,314	6,348	29,662			295	29,957
Tuna, Bluefin						910,473	336,771	1,247,244		747,085		1,994,329
Tuna, Bonito						981,688	23,518	1,005,206		136,180		1,141,386
Tuna, Skipjack										932,180	972,997	1,905,177
Tuna, Yellowfin										3,004,226	7,516,015	10,520,241
Turbot			10,339	552				10,891				10,891
Whitebait	11,007		5,837	1,299				19,043				19,043
Whitefish, Ocean					15	269		284			609	893
Yellowtail						5,251	56,342	61,596		312,334	263,760	638,190
Miscellaneous Fish	18,290		1,042	801	3,575	3,158	240	27,109	1,175			28,284
Crustacean:												
Crab	305,645		377,318	10,122				693,085	2,328			695,413
Crab, Rock						200		200				200
Shrimp			224,913					224,913				224,913
Mollusk:												
Abalone				33,300	102,050	413		136,363				136,363
Clam, Cockle			23			2,250		2,273				2,273
Clam, Gaper			454					454				454
Clam, Pismo					17,589			17,589				17,589
Clam, Razor	50							50				50
Clam, Soft-shell	75		7,016					7,091				7,091
Clam, Washington			434					434				434
Octopus			135	2,950		1		3,086				3,086
Oyster, Eastern			5,584					5,584				5,584
Oyster, Japanese			77,823		2,320			80,143				80,143
Oyster, Native			1,641					1,641				1,641
Scallop									300			300
Squid				302,820		335		303,155				303,155
Total pounds	1,387,149	60,573	1,031,170	950,142	1,544,820	3,032,848	1,401,102	10,008,113	85,104	5,158,669	8,808,915	24,060,591

*See footnote to table for April.

SHIPMENTS OF FRESH FISH FROM OTHER STATES AND FOREIGN COUNTRIES

April, 1939

	Gulf of California	Japan
For canneries:		
Tuna, Albacore		924,098
Tuna, Skipjack		24,072
For fresh fish markets:*		
Corbina, Mexican	360	
Sea-bass, Totuava	344,654	
Total pounds	345,014	948,170

May, 1939

	Gulf of California	Japan
For canneries:		
Tuna, Albacore		436,152
For fresh fish markets:*		
Cabrilla	11,353	
Corbina, Mexican	98	
Sea-bass, Totuava	270,753	
Total pounds	282,204	436,152

June, 1939

	Gulf of California	Japan
For canneries:		
Tuna, Albacore		1,202,295
For fresh fish markets:*		
Cabrilla	12,927	
Corbina, Mexican	2,068	
Sea-bass, Totuava	74,386	
Total pounds	89,381	1,202,295

*This record includes only that fish which is voluntarily reported to the Division of Fish and Game and does not represent all shipments.

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Clarence Elliger, Assistant Hydraulic Engineer ..... San Francisco
Byron Wittorff, Assistant ..... San Francisco

BUREAU OF LICENSES

H. R. DUNBAR, Chief ..... Sacramento
J. J. Shannon, License Agent ..... Sacramento
L. O'Leary, License Agent ..... San Francisco
R. Nickerson, License Agent ..... Los Angeles

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol ..... San Francisco

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Owen Meile, Warden ..... Pacific Grove

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Ralph Classic, Captain ..... Monterey
Kenneth Hooker, Warden, Cruiser *Quinnat III* ..... San Francisco
Richard Hardin, Assistant Warden, Cruiser *Quinnat III* ..... San Francisco
C. Apsley, Assistant Warden, Launch *Sturgeon* ..... Martinez
Leslie E. Lahr, Warden ..... Eureka
W. J. Black, Warden ..... Monterey
S. R. Spratley, Warden ..... Richmond
Ralph Miller, Warden ..... San Francisco

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Western Division

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Fred Albrecht, Warden, Los Angeles County ..... Los Angeles
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Walter Emerick, Warden, Los Angeles County ..... Palmdale
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R. E. Bedwell, Warden, Santa Barbara County ..... Santa Barbara
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Theo. Jolley, Warden ..... Los Angeles
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Eastern Division

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C. J. Walters, Warden, Inyo County ..... Independence
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W. S. Talbott, Warden, San Bernardino County ..... Big Bear Lake
Charles Mayfield, Warden, Orange County ..... Orange

Marine Fisheries Detail (Southern District)

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Lars Weseth, Master, M. V. *N. B. Scofield*	Terminal Island
Walter Engelke, Master, M. V. *Bluefin*	Terminal Island
Howard V. Shebley, Warden, Cruiser *Bonito*	Terminal Island
Kenneth Webb, Assistant Warden, Cruiser *Bonito*	Santa Barbara
John Spicer, Warden, Cruiser *Broadbill*	Santa Barbara
John Barry, Assistant Warden, Cruiser *Broadbill*	Santa Monica
E. L. Walker, Warden, Cruiser *Marlin*	Santa Monica
Niles Millen, Assistant Warden, Cruiser *Marlin*	San Diego
Carmi Savage, Warden, Cruiser *Tuna*	San Diego
B. J. Avise, Assistant Warden, Cruiser *Tuna*	Avalon
E. R. Hyde, Warden, Cruiser *Yellowtail*	Avalon
L. R. Metzgar, Assistant Warden, Cruiser *Yellowtail*	Balboa
Lester Golden, Warden	Balboa
T. J. Smith, Warden	Arroyo Grande
E. A. Chan, Warden	San Diego
Donald Glass, Warden	Terminal Island
Erol Greenleaf, Warden	Terminal Island
N. C. Kunkel, Warden	Terminal Island
Tate F. Miller, Warden	Terminal Island
T. W. Schilling, Warden	Terminal Island
L. G. Van Vorhis, Warden	Terminal Island

POLLUTION DETAIL

Paul Shaw, Chemist in Charge	San Francisco
C. L. Towers, Warden	Los Angeles
Jack McKerlie, Warden	Oakland
J. A. Reutgen, Assistant Warden, Launch *Rainbow*	Stockton
R. Schoen, Warden	Terminal Island
H. A. Erwick, Assistant Warden	San Francisco
Clarence Whaley, Assistant Warden	Terminal Island
E. Dennett, Assistant Warden	Willow Creek

CALIFORNIA JUNIOR GAME PATROL

M. F. Joy, Warden, Superintendent Junior Game Patrol	San Francisco
Geo. D. Seymour, Assistant, Junior Game Patrol	San Francisco
C. H. Edmondson, Assistant, Junior Game Patrol	Los Angeles

MARINE PATROL AND RESEARCH

Motor Vessel *N. B. Scofield*, Terminal Island
Motor Vessel *Bluefin*, Terminal Island
Cruiser *Yellowtail*, Newport Harbor
Cruiser *Broadbill*, Santa Monica
Cruiser *Quinnat III*, San Francisco
Cruiser *Bonito*, Santa Barbara
Cruiser *Marlin*, San Diego
Cruiser *Tuna*, Avalon
Launch *Rainbow*, Stockton
Launch *Shrapnel*, Lakeport
Launch *Sturgeon*, Martinez
Launch *Perch*, Sacramento

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